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LIPOID PNEUMONITIS

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At least since 1920, it has been known that certain oils, when introduced into the lungs, are capable of causing marked reactive alterations of the pulmonary tissues, for in that year Guieysse-Pellissier (1) produced such reactions in animals by intratracheal injections of olive oil. This fact was confirmed and amplified, in 1922, by Corper and Freed (2), who found that intratracheal injections of chaulmoogra oil, olive oil, or liquid petrolatum gave rise to a proliferative bronchopneumonia. For a time, however, the practical implications and clinical significance of these experimental demonstrations were not appreciated, and no one seemed to suspect that lipoids in food or commonly administered intranasal and gastro-intestinal medicaments might often find their way into the pulmonary parenchyma and there produce grave organic changes.

In 1925, Laughlen (3) reported four instances of lipoid pneumonia in children, following the administration of mineral oil for therapeutic purposes; he described the morbid anatomy as found at necropsy, and confirmed the etiologic factor by experiments on animals. In the following year, Thomas and Jewett (4) recorded an instance of lipoid pneumonitis caused by aspiration of food fats during attempts at forced feeding in a case of cardiospasm. Pinkerton's report (5), in 1927, of four cases and his lucid exposition of the pathologic and clinical aspects of the affection attracted attention, but for five years thereafter no new contributions were made. In 1932, activity in this field was vigorously renewed, and since then many papers have appeared, including those of Pierson (6, 7), Fischer-Wasels (8), Bodmer and Kallos (9, 10), Grayzel and DuMortier (11), Rabinovitch and Lederer (12), Ellinger (13), Goodwin (14), Pollak and Potter (15), Hayes and Gardner (16), Ikeda (17, 18), Graef (19), Karelitz and Denzer (20), Davis (21), Tchertkoff and Ornstein (22), and Fetterman (23). Altogether, not less than 72 cases of lipoid pneumonitis or pneumonia, proved by necropsy or by convincing clinical and roentgenologic data, have been recorded, most of them within the past six years.

From evidence already at hand, it is clear that lipoid pneumonitis is not merely a pathologic curiosity but is a rather common affection, and that it is often marked by a roentgenologic or clinico-roentgenologic syndrome that is either strongly suggestive or virtually pathognomonic. To the radiologist, therefore, the disease is of almost fascinating interest, for, as a rule, he has the most favorable opportunity to establish or suggest the diagnosis, and out of the past he can recall many instances in

which he failed to recognize the affection because he did not then know that such a disease existed.

Among fats and oils that have been shown either clinically or experimentally to be productive of lipoid pneumonitis are liquid petrolatum, vaseline, milk fat, lard oil, cod liver oil, egg yolk, chaulmoogra oil, and olive oil. It seems reasonable to assume, therefore, that almost any lipoid, whether of mineral, animal, or vegetable origin, when taken into the lungs in sufficient amount, may give rise to the disease. The pathologic capability of mineral oil is not open to doubt, for it was the causative agent in most cases of lipoid pneumonitis thus far recorded. Reactions to animal oils have been most severe and most rapid. Evidence has been obtained that the severity of the reaction depends largely on the amount of free fatty acid present in the oils and the rapidity with which hydrolysis progresses (Pinkerton, 24). Vegetable oils appear to be least provocative of tissue reaction, and the ability to produce morbid changes in the lungs seems to vary among different oils. Investigators have found oil of sesame and poppy seed oil to be practically inert. Although iodized poppy seed oil has been employed freely for many years in bronchography, no instance of resulting lipoid pneumonitis has been recorded. Wright (25) has pointed out that lipiodol is usually expelled before reactive changes in the lungs are induced, and that if it is retained for long periods, no epithelial reaction occurs although lipophages accumulate. Pinkerton's (24) experiments with lipiodol were even more nearly negative, and he found that the mononuclear reaction to olive oil was slight. Nevertheless, all investigators regard all vegetable oils with distrust, and further research will be necessary to determine their degree of pathologic potency and its clinical import.

That mineral oil is the most common cause of lipoid pneumonitis is not surprising since sprays containing liquid petrolatum have long been prescribed for affections of the upper portion of the respiratory tract, similar proprietary sprays and ointments are widely employed for self-treatment, and mineral oil is in common use as a laxative. In the reported cases of lipoid pneumonitis caused by petrolatum, the medicament had been used in excessive amounts, or for long periods, or under abnormal conditions, and there is no reason to suppose that the rational employment of petrolatum under ordinary circumstances is hazardous. Likewise in many of the cases in which lipoids of animal or vegetable origin were primarily responsible there were also other contributing etiologic factors. In almost all the first cases reported, the patients were infants and children who were ill nourished and required forced feeding or who had difficulty in swallowing from various causes, such as cleft palate or a recent tracheotomy. Indeed, although one of Laughlen's patients was an adult, the impression became prevalent that lipoid pneumonitis is confined to children. This impression was corrected later by further reports of lipoid pneumonitis in adults. Here, again, many of the patients were feeble, or had obstructive lesions of the esophagus or paralysis of the muscles of deglutition, so that aspiration of oils and fats was favored. Often, however, such contributing conditions were not present, and the pulmonary disease was due solely to intranasal applications of oils in immoderate quantities or for long periods. In explanation, it has been pointed out that some of the liquid petrolatum usually employed in intranasal sprays and drops often descends quickly into the bronchi and pulmonary alveoli and is not sufficiently irritating to stimulate its expulsion by coughing. Oil is carried out by action of the cilia, but their capability in this respect is limited and if the amount of aspirated oil is excessive, constant or cumulative residues remain in the lung and produce morbid changes.

Descriptions of the pathology of lipoid pneumonitis are comparatively uniform and the morbid changes occur in such logical sequence that they are readily comprehensible. First in importance is

the somewhat peculiar localization of the disease, for it affects predominantly, and often exclusively, the central and lower portions of the lungs, especially the basal, circumhilar, and paramediastinal segments of the lower lobes. Occasionally, the base of the right middle lobe is implicated, but involvement of the upper lobe is not common. Often, posterior portions of the lower lobes are more markedly affected than anterior portions. Almost invariably the disease is bilateral, and frequently it is roughly symmetrical, but the earliest and most extensive involvement is likely to be on the right.

The pathologic process begins in the alveoli. There, the collections of lipoid material are invaded by a multitude of phagocytes, which individually envelop particles of the material and solidify the oily accumulations. Epithelial cells lining the alveoli become cuboidal. Lipoid-laden phagocytes penetrate the alveolar walls, infiltrate the interstitial tissue and enter the lymph channels. Masses of phagocytes break down and release their lipoid contents, which are again enveloped in other phagocytes and giant cells, forming tumefactions like paraffinomas. Lymph channels become obstructed, lymph nodes enlarge, and new nodes form. Marked fibrosis ensues, bronchioles are constricted and many corresponding alveoli dilate or collapse. With further contraction of the fibrous tissue, lobules or entire lobes become shrunken and retracted in varying degrees. The rounded or ovoid tumor-like masses, which may attain considerable size, become firm and sharply defined. Small or moderate pleural effusions may occur. Finally, as a result of infection, acute, recurring, or migrating bronchopneumonia, varying in extent, often is added to the morbid anatomic ensemble.

In uncomplicated cases the symptoms and signs are comparatively meager and often perplexing. Cough, which may or may not be productive, is common. Hemoptysis, usually slight, seems to occur in a considerable proportion of cases. The patients are afebrile. Râles are likely to be heard and local regions of dullness may be distinguishable, but the physical signs are not pronounced or in proportion to the extent of the disease. Thus, in the clinical manifestations as ordinarily elicited, there is nothing directly suggestive of lipoid disease. When bronchopneumonia complicates the lipoid affection at any stage, the rise in temperature, dyspnea, cough, and physical signs are sufficiently characteristic of pneumonia but give no hint of the concomitant lipoid disease. To aid clinical search for indications that may lead to the diagnosis of lipoid pneumonitis, whether complicated or not, two suggestions have been offered: (1) that the sputum be examined for droplets of oil, and (2) that an inquiry as to whether the patient has employed any form of intranasal medication be included habitually in the clinical questionnaire.

Lipoid pneumonitis plus bronchopneumonia is a grave combination of diseases and is often fatal, especially in infants. Indeed, it was the numerous fatalities among infants and the subsequent necropsies that led to identification of lipoid pneumonitis as an entity among diseases. On the other hand, in mild or even severe cases of uncomplicated lipoid pneumonitis, restoration to normal follows rather quickly when further aspiration of lipoids is stopped and postural drainage is instituted, although in chronic cases with extensive fibrosis and contraction, anatomic restitution cannot be expected.

From the many roentgenologic observations of lipoid pneumonitis that have been recorded, all of which were in consonance with its well studied morbid anatomy, certain generalizations as to the roentgenologic aspects of the disease can be derived, subject to revision and amendment as experience increases further. Obviously, the roentgenologic manifestations necessarily vary according to the stage of disease and the presence or absence of complicating bronchopneumonia. In early, mild, uncomplicated cases, fleck-like shadows appear in the basal and central portions

of both lower lobes, often predominating on the right and sometimes involving the right middle lobe. The flecks extend to the periphery of the lung, and the entire appearance, which Davis thought was best described by the term "miliary mottling," is logically attributable, as he suggested, to the alveoli with their thickened walls and phagocytosed lipoid contents. With further advancement of the disease, the bronchovascular-lymphatic markings become more accentuated and nodulated, and, in severe cases, gross, irregularly shaped, rather dense, discrete and confluent shadows of consolidations are interspersed through the region. Eventually, in chronic and severe cases, there is striking evidence of fibrosis, with strand-like shadows along the bronchovascular trunks together with dense, sharply defined, irregular or rounded shadows, varying in size, number, and distribution, but often largest or most numerous in the hilar regions. To the picture may be added the signs of local atelectasis, compensatory emphysema, or effusion. As a result of fibrous contraction, an entire lobe may be represented by the dense rounded shadow of a tumor-like mass. When bronchopneumonia from infection supervenes, as it may at any stage of the lipoid disease, the roentgenologic signs become more extensive and complex in ratio to the amount, intensity, and site of bronchopneumonic involvement.

The roentgenologic differential diagnosis requires consideration of so many other diseases which give rise to more or less similar manifestations that the possibility of making a definite or even tentative roentgenologic diagnosis may seem doubtful. The miliary mottling produced by early uncomplicated lipoid pneumonitis might perhaps be attributed to miliary tuberculosis, miliary metastasis, or bronchiolitis obliterans, but the situation of the lesion is not characteristic of any of these diseases. Advanced lipoid disease, with gross consolidated patches, has been mistaken for tuberculosis and bronchiectasis. At this stage also, dense masses around the hilus may be suggestive of primary carcinoma of the lung, or rounded masses elsewhere may simulate those of malignant metastasis. When fibrosis is obviously dominant, the examiner may think of pneumoconiosis, and he will not be altogether wrong although he will be thinking of silicosis or anthracosis instead of lipoidosis.

Notwithstanding these and other simulants, the usual bilateral, basal, paramediastinal, and circumhilar localization of lipoid pneumonia is strongly suggestive if not distinctive, and its diagnosis, like that of many other diseases, requires chiefly that the affection be considered among the alternatives. When bronchopneumonia is added to lipoid disease, only the former is likely to be recognized, but when the lipoidosis is advanced, its manifestations should at least arouse suspicion that something more than bronchopneumonia is present. In any case, whether complicated or not, the final diagnosis should rest on a correlation of the roentgenologic and clinical data. Both clinician and roentgenologist have an opportunity to elicit potential indexes of the disease and by co-operative effort should, in most instances, be able to identify it.

Since the recognition of lipoid pneumonitis as a pathologic entity, many cases believed to be instances of the disease have been encountered at the Clinic. Most of them, however, were of the mild type, were merely incidental to graver disorders, and the roentgenologic, clinical, and pathologic evidence was incomplete. Disappearance of the pulmonary lesions after self-administration of oils is stopped is fairly conclusive, but usually this proof was lacking because no opportunity for subsequent roentgenologic examination was afforded. Of the whole group, therefore, only five cases will be described here.

REPORT OF CASES

Case 1. A man, aged 46 years, came to the Clinic on Aug. 3, 1934, complaining of hoarseness for the past four months. A diagnosis of carcinoma of the larynx was made. Roentgenograms of the thorax at

that time gave negative results. Tracheotomy was performed on Aug. 13, and laryngectomy on Sept. 6. The pathologist's report was: "Squamous-cell epithelioma, Grade II." As usual, a tracheotomy tube was inserted after laryngectomy. To soften and favor expulsion of the tracheal incrustations that commonly follow, the patient was directed when he left the hospital to apply one or two drops of liquid petrolatum twice daily. The patient assuming that the oil was harmless disregarded his instructions and applied the oil freely, often two or three pipetfulls at a time. Roentgenograms of the thorax made two months later depicted a symmetrical bilateral pneumonitis at the bases of the lungs (Fig. 1). The patient died on March 11, 1935. At necropsy, in addition to local recurrence and metastasis of the carcinoma, bronchopneumonia of both lungs was found. The lungs contained considerable quantities of oil, and the pathologist attributed the bronchopneumonia to this cause (Fig. 2).

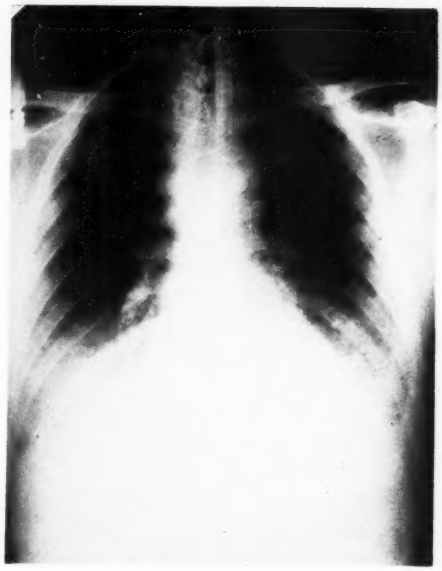

Fig. 1. Pneumonitis of both lower lobes (Case 1).

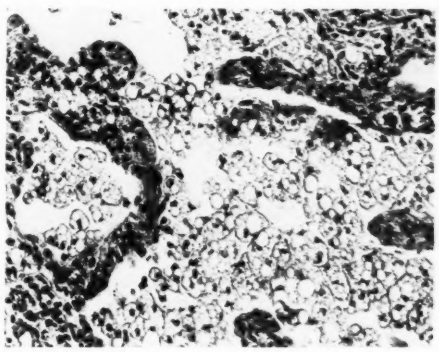

Fig. 2. Microscopic appearance of lung (Case 1).

Case 2. A physician, aged 77 years, came to the Clinic on Oct. 10, 1936. For ten years he had had dysphagia with regurgitation of food and this had grown markedly worse during the past three years previous to registration at the Clinic. Eighteen months before he came to the Clinic, a diagnosis of diverticulum of the esophagus had been made, elsewhere. Roentgenologic examination at the Clinic disclosed a large pharyngo-esophageal diverticulum. Roentgenograms of the thorax depicted diffuse bilateral and symmetrical pneumonitis at the bases of the lungs (Fig. 3). As the patient had a diverticulum and was in the habit of taking mineral oil as a laxative, the pneumonitis was attributed to aspiration of oil.

Case 3. A man, 54 years of age, registered at the Clinic on May 19, 1938. His chief complaint was of difficulty in swallowing, with some nocturnal regurgitation for 18 months. His voice was husky, he had moderate dyspnea, and had had a cough during the year previous to registration at the Clinic. He had been taking mineral oil as a laxative for several months. Roentgenologic examination of the esophagus disclosed a pharyngo-esophageal diverticulum 4 or 5 cm. in diameter. Roentgenograms of the thorax exhibited diffuse bilateral pneumonitis in the lower portions of both lungs. In view of the fact that the patient had been taking mineral oil, a diagnosis of lipoid pneumonitis was made.

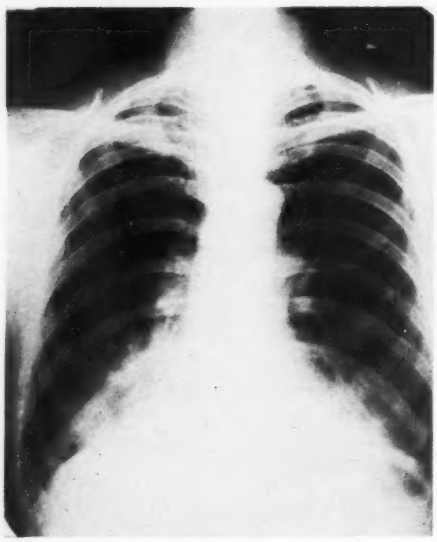

Fig. 3. Pneumonitis of both lower lobes (Case 3).

Case 4. A woman, aged 40 years, came to the Clinic on May 28, 1936. She complained of dysphagia during the previous 16 years. Because of loss of weight, she had been treated for a time for tuberculosis, but a diagnosis of cardiospasm had been made one year before her appearance at the Clinic. The cardiospasm with marked dilatation and tortuosity of the esophagus was readily demonstrable. Roentgenograms of the thorax disclosed bilateral and symmetrical miliary infiltration in the central portions and bases of the lungs. As the patient had long taken mineral oil for constipation and often had nocturnal regurgitation, the pulmonary condition was tentatively diagnosed as lipoid pneumonitis. The cardiospasm was relieved by dilatation with bougies up to No. 26 F, and the patient was advised to discontinue taking mineral oil.

Case 5. A man, aged 63 years, registered at the Clinic on Aug. 30, 1937. Five months previously he had had a severe cold with cough and loss of appetite, both of which had since continued. He had lost 14 pounds (6.4 kg.) in weight. He stated that a roentgenologic diagnosis of "pus-pockets" in the lungs had been made. Roentgenologic examination at the Clinic disclosed general bilateral pneumonitis. The roentgenologist surmised that the pneumonitis might be due to aspirated oil and asked the clinician to inquire concerning this factor. It was found that the patient had been using a nasal spray with an oily base. Two months after the patient discontinued using the spray, roentgenologic examination showed a marked diminution of the pneumonitis.

SUMMARY

That aspiration of fats and oils into the lungs may give rise to a special variety of pneumonitis was determined experimentally as early as 1920, but only in recent years has it been realized that lipoid disease of the lungs occurs sufficiently often to make it a relatively important pathologic and clinical entity, and the number of cases reported is steadily increasing. Almost any oil, whether derived from mineral, animal, or vegetable sources, may produce the disease, but because of its wide employment, liquid petrolatum is most often responsible. Dysphagia from any of its numerous causes is a common contributing factor.

Pathologically the disease is characterized primarily by its peculiar localization, in that it affects predominantly, often solely, the basal and paramediastinal portions of both lungs. Masses of phagocytes invade the collections of oil in the alveoli, penetrate the alveolar walls, enter and obstruct the lymphatic vessels, and form tumefactions like paraffinomas. Fibrosis with variable degrees of contraction constitutes the final stage. At any stage, bronchopneumonia from infection may be added.

Symptoms and physical signs of mild uncomplicated lipoid disease are meager, but the roentgenologic manifestations accurately reflect the morbid anatomic changes. When bronchopneumonia is superimposed, the lipoid factor is likely to be overlooked both clinically and roentgenologically. The five cases of lipoid pneumonitis here re-

ported briefly are representative. One case was confirmed by necropsy.

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THE DIAGNOSIS AND TREATMENT OF CANCER OF THE TONSIL[1]

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AS noted in our records for the years 1915 to 1935, cancer of the tonsil had an incidence of approximately 1 per cent of all cancer and constituted 10 per cent of all intra-oral cancers. Of the cases noted, 91 per cent were in males, the period of greatest prevalence being in the fifth and sixth decade in which approximately two-thirds of the patients were observed (Table I). The youngest

TABLE I.—CLASSIFICATION ACCORDING TO AGE AND SEX

Decade	Male	Female	Total	Percentage
80–89	5	0	5	3.0
70–79	28	2	30	18.5
60–69	47	2	49	30.2
50–59	47	7	54	33.3
40–49	17	2	19	11.7
30–39	3	1	4	2.4
20–29	1	0	1	0.6
Total	148 or 91.3%	14 or 8.6%	162	99.7

and oldest cases were in men of 28 and 85 years, respectively. A recent case so diagnosed pathologically was noted in a boy of 12 years, but as this case is controversial from the clinical angle, it will not be included here. Similar studies by Bervan, Coutard, Duffy, Schall and others confirming these findings are commended to the reader's attention.

The etiology, as in cancer in general, seems best attributed to an intrinsic hereditary or acquired predisposition, in addition to a chronic irritation acting as a localizing extrinsic factor. Bad oral hygiene, syphilis, excessive use of tobacco, and so forth, undoubtedly play a rôle.

[1] Presented before the Radiological Society of North America, at the Twenty-fifth Annual Meeting, at Atlanta, Dec. 11–15, 1939.

DIAGNOSIS

This should be both clinical and pathological. These patients generally come to the family physician complaining of chronic sore throat, a fullness, catch, or slight pain on swallowing which is located in the region of the tonsil. Occasionally blood-tinged sputum will be noted. Pain referred to the ear of the side of involvement is a frequent symptom which, like trismus and glandular metastasis to the upper cervical nodes, signifies more extensive and late forms of the disease.

A simple inspection of the palatine fauces will generally disclose the condition when it exists. Visual examination should not suffice but should always be accompanied by palpation with the gloved finger for further confirmatory evidence. This latter procedure is often neglected and most unfortunately so, as the sense of induration commonly associated with cancer is probably one of the earliest presumptive evidences of this disease.

In the common or squamous-cell types, the affected tonsil is indurated, ulcerated, enlarged, fungating, or infiltrating. The lesion may not only involve the tonsil but also any or all of the adjoining structures, *i.e.*, the pillars, soft palate, adjoining edge of the tongue, uvula, pharyngeal wall, etc. In any case, the clinician should record carefully the anatomical extent of involvement, together with the absence or presence of nodes in the adjoining cervical chain, their consistency, degree of fixation, etc. Such description aids in the effort to classify these lesions from the prognostic and therapeutic viewpoints.

In a smaller number of cases, the tonsil will appear as a unilateral hypertrophy with little or no surface ulceration and little or no induration to the palpating

finger. In fact, the whole clinical picture may resemble that of lymphosarcoma rather than epithelioma. In such cases, early metastatic involvement of the glands in the upper anterior cervical triangle of the neck often suggests the diagnosis of the anaplastic, transitional, or lympho-epithelioma type, in contradistinction to the usual squamous-cell lesion, in which cervical metastasis is generally a later incident. At any rate, the finding of metastatic nodes in the neck should always place upon the examiner the responsibility of making an exhaustive search of the upper respiratory passages for a primary source. In fact, an unfavorable prognosis seems to be more intimately and conservatively bound up with the presence of metastatic involvement of these first-line sentinal nodes at the angle of the jaw than with almost any other clinical or pathologic finding. Biopsy of either the primary lesion or the secondary adenopathies should be resorted to for confirmatory pathologic evidence in all cases, and does not harm provided adequate treatment follows soon after. Such biopsy is most easily obtained under local infiltration of the tonsil or the skin area overlying the nodular mass with 1 per cent novocain, being sure to take sufficient representative tissue from the actively growing portions of the lesion. This tissue should be immediately fixed in 10 per cent formalin for submission to the pathologist.

Glandular metastasis may frequently be confirmed by aspiration biopsy, as advocated by Martin and Ellis, or by use of the Silverman needle. The pathologist will often prefer the fixation of the plugs of tissue so obtained in 10 per cent formalin solution, rather than smears of the crushed tissue as originally advocated by Martin. Operative exposure with excision of the gland can be resorted to in cases in which the nodes are still movable. In such cases this area should have been thoroughly irradiated prior to exposure and excision, making use of table diagnosis, so that radon seeds of gold may be implanted in the node if not resectable or into the tissue bed when cancer cells are found in the biopsy material.

The pathologic diagnosis is generally a simple matter for a well trained tumor pathologist. The frozen section method is used here and recommended by most tumor clinics. The most common finding is that of the squamous-cell epithelioma with or without pearl formation. Next are the transitional type or lympho-epitheliomas of Schmincke or Regaud types, and least common the adenocarcinomas and spindle-cell anaplastic types. Table II, showing the histopathologic findings and a schematic classification of the pathologic material in 62 more recent cases as studied by the writer, is appended, together with photomicrographs representative of these various types as shown in Figure 1.

TABLE II.—HISTOPATHOLOGIC CLASSIFICATION

(Based on the findings in 57 cases)

Group	Description	Percentage
I	Adenocarcinomatous or glandular	1.7
II_a	Epidermoid type with pearl formation	54.3
II_b	Mucous membrane type	21.0
III	Transitional or basal-cell type	15.8
IV	Lympho-epithelioma Schmincke or Regaud type	5.2
V	Undifferentiated or non-epidermoid	1.7
	Total	99.7

THERAPEUTIC MANAGEMENT

After securing a positive pathologic diagnosis, the patient should be subjected to external irradiation to include the tonsilar area of the side involved and its gland-bearing first line defenses. Generally, this can be accomplished by 200 kv. x-ray therapy of 0.16 Å. λ eff. or shorter wave length, including teleradium pack if available, applied so as to irradiate thoroughly not only the tonsilar and glandular area of the involved side, but also to include by cross-fire method the healthy side of the neck. Such therapy should be given over a period of from 20 to 30 days, preferably according to fundamental principles outlined by Coutard. Approxi-

mately 3,500 r (primary or air-measured radiation) or 5,500 r (secondary or tissue-scattered radiation) are given over as small a skin portal, generally 50 to 100 sq. cm., as is consistent with adequate coverage of the lesions. After the subsidence of mucositis, the residual tonsilar tumor should be "implanted," under local infiltration of novocain, with radon gold seeds of not to exceed 1 mc., each as determined by the writer's experience, or similar small removable radium needles of heavier filtration and low intensity.

During the course of such x-ray or

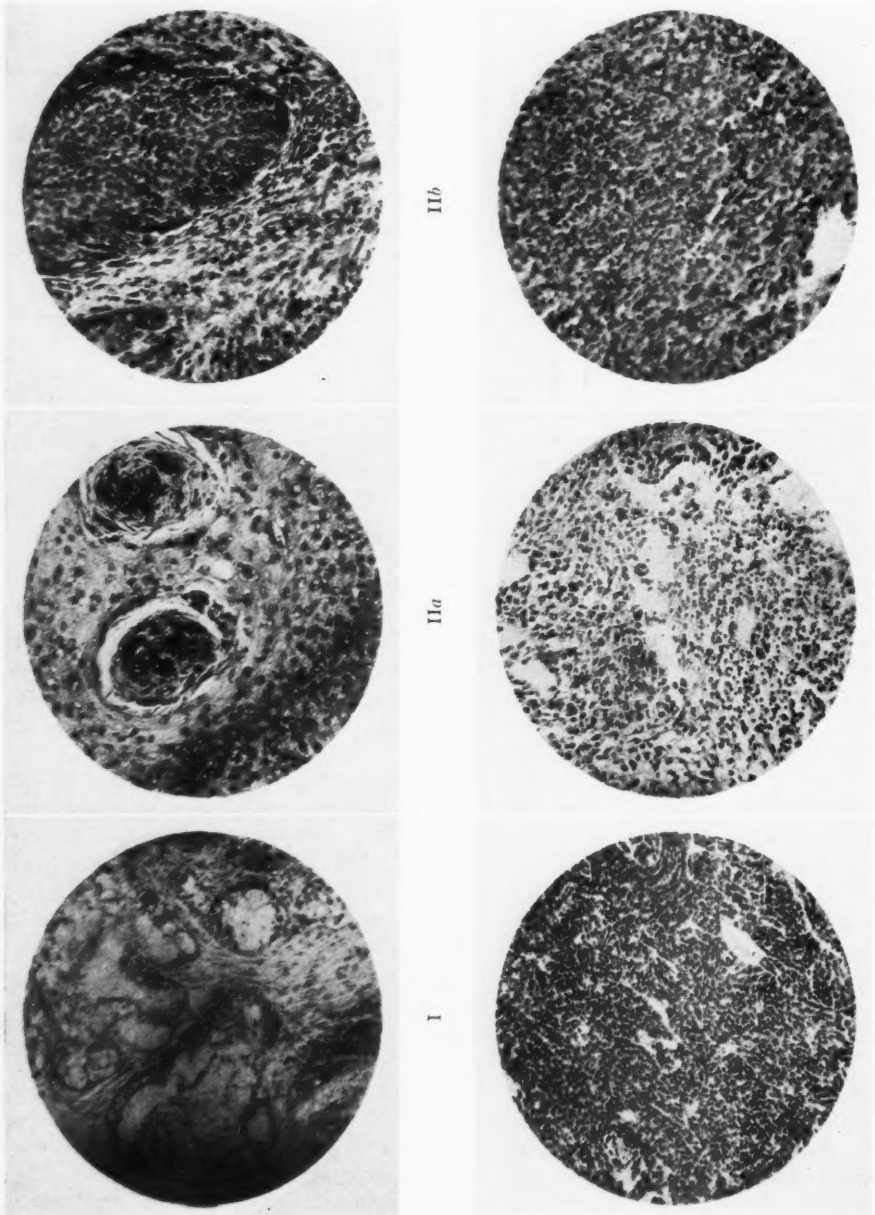

Fig. 1. Photomicrographs of representative sections depicting the various groups as noted in Table II. The designation under each illustration corresponds with the grouping as shown in the table.

radium therapy careful oral hygiene should be instituted, using copious and frequent cleansing gargles or sprays of hydrogen peroxide and water, equal parts, or alkaline antiseptic solutions as represented by Seiler's or similar tablets, many times daily. Whereas it is most ideal for the external irradiation therapy to precede the internal implantation of radon gold seeds, the experience of the writer has shown that apparently as successful results may be obtained in cases in which this procedure had to be reversed, due to the financial status of the patient.

Local extensions or recurrences may be treated by further radon gold seed implants of low intensity, intra-oral x-ray or radium intra-oral molded applicators. External irradiation should not be repeated within a period of from three to four months after the first application.

When the primary lesion has healed and pathologic demonstrable metastases still persist in the isolated cervical nodes, exposure and excision of these glands, with radon seeding of the tissue bed, may be resorted to in cases in which the growth has not invaded the capsule. If the capsule of the glands has been invaded with resulting fixation of the surrounding tissues, such nodes had best be seeded *in situ* without attempt at removal. In prospective cases of the squamous-cell variety, in which the primary tonsilar growth remains healed and in which the above outlined course of irradiation has failed to cause regression of such metastatic nodes, radical neck dissection under novocain block may be resorted to. This applies in operable cases in which the nodes are still movable and not too extensively involved, in younger and healthier individuals who have a goodly chance of three or more years' survival following recovery from such an ordeal.

A recent paper by Cohn describes this technic in selected cases. Anaplastic types of lesions are best treated exclusively by irradiation. This conservative practice has resulted in reducing to a minimum the apparent necessity for radical dissection of the cervical glands in the larger tumor clinics.

PROGNOSIS

Under the former surgical management, prospects of three or more years' arrest of the disease were quite infrequent, even in the hands of master surgeons after careful selection of cases. Earlier radiologic therapy, while it often promoted primary healing, was most often a palliative procedure only. Since the advent of improved methods, three-year arrests from this disease may be expected in from 35 to 40 per cent of the earlier cases, without metastasis, as has been outlined. Such therapy, while less drastic than the formerly proposed radical surgical procedures, still carries a slight mortality and considerable morbidity. This is due to skin and mucosal irradiation reactions which may be quite extreme in some few cases and result in marked loss of appetite, painful deglutition, dehydration, etc. Elderly or debilitated patients may even succumb to bronchopneumonia during the course of such reactions and, therefore, had better be hospitalized during treatment.

On the other hand, there is no known present-day therapy which will, with less inconvenience to the patient, produce the results seen in these more favorable early cases in which the first line defense glands are apparently not involved. If the encouraging results seen here could be duplicated in other types of malignancy of the upper respiratory tract, cancer therapy to-day could be more optimistically considered.

In the group with metastatic glandular involvement of the cervical nodes, the results, while less spectacular, are even equally impressive, for it was in this group that little or no surgical aid was previously offered. In the earlier days of such therapy here, the results were quite discouraging, only 1 per cent of patients remaining alive over three years. In a later series of cases under improved irradiation technic, results have jumped to 19 per cent three-year arrests of all mani-

festations of the disease. A summary of these results and the improvement achieved can be appreciated best by reference to Table III. In the writer's experience, the presence of metastatic nodes and the extent of clinical involvement were better criteria of prognosis than the histopathologic findings.

In light of the present experience and similar reports as previously mentioned, it seems logical to assume that irradiation should be the method of choice in the management of cancer of the tonsil, at least until basic science shows us better means of therapeutic approach to the cancer problem.

TABLE III.—RESULTS OF THERAPY IN 162 CASES

Clinical Classification	1915 to 1929			1929 to 1932			1932 to 1935		
	No. cases	No. well 3 yrs.	Percentage well 3 yrs.	No. cases	No. well 3 yrs.	Percentage well 3 yrs.	No. cases	No. well 3 yrs.	Percentage well 3 yrs.
Group I with no demonstrable involvement of cervical nodes	21	3	14	6	2	33.3	9	4	44
Percentage of incidence	22.1%			22.2%			22.5%		
Group II with demonstrable involvement or induration of cervical nodes	74	1	1.4	21	1	4.7	31	6	19.3
Percentage of incidence	77.9%			77.8%			77.3%		
Results	95	4	4	27	3	11.1	40	10	25
Therapy	Glass seeds. λ eff.	or gold 200 kv. Older	radon 0.16Å. technic	1.5 to 2 mc. gold radon seeds. Protracted 200 kv. 0.16 Å. λ eff. x-ray or teleradium pack			1 to 1.5 mc. gold radon seeds. Protracted 200 kv. 0.16 Å. λ eff. x-ray or teleradium pack up to 400 r per field		

Primary healing was observed in 36 of 57 cases, or 63.5 per cent, from 1929 to 1935. Of these, 23, or 63.8 per cent, developed local recurrence.

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DISCUSSION

CLAYTON W. ELEY, M.D. (Norfolk, Va.): There is not a great deal I can add to the excellent presentation by Dr. Mattick. He has covered the subject thoroughly and has given us interesting statistics based upon a wide experience in handling these cases. I congratulate him on his results. It is a well established fact that the treatment of all carcinomas and lympho-epitheliomas of the tonsil is a radiologic problem and that surgery is invariably unsuccessful, as it is usually followed by early recurrence and more widespread dissemination.

Malignant tumors of the tonsil may be confused with lesions arising in neighboring structures, with secondary involvement of the tonsil. Such tumors are usually of a more differentiated type with a tendency to early invasion of the surrounding musculature, whereas the tumors originating primarily in the tonsil are more apt to be of an anaplastic type, with a lesser tendency to infiltration. The undifferentiated, or anaplastic character of the primary tonsilar lesions, growing in a loose vasculo-connective tissue, rich in lymphoid elements, renders them much more

amenable to radiologic treatment and, therefore, the prognosis is considerably better than for other tumors originating in the immediate neighborhood of the tonsil and involving it secondarily.

As stressed by the essayist, it is very important that examination of the tumor should include palpation with the gloved finger, to detect induration, evidence of extension to neighboring tissues, or associated adenopathy. Metastasis to cervical lymph nodes occurs early in carcinomas of the tonsil and further lymphatic spread may occur from the submaxillary region to the deep cervical and supraclavicular lymph nodes.

Biopsy of either the primary lesion, or secondary adenopathies should be resorted to in all cases, but in the non-ulcerative lesions, I feel that it should be taken with more caution, preferably after preliminary irradiation. One reason for this is the possibility that some of these lesions may be lymphosarcoma.

As to the therapeutic management of carcinoma of the tonsil, I thoroughly indorse the plan outlined by the essayist, that is, thorough external roentgen irradiation, or teleradium pack, if available, supplemented by the implantation of gold radon seeds in the primary lesion and persistent lymph nodes.

In selected cases, a portal through the open mouth obtained by the use of a specially constructed metal cone or cylinder may be employed when the jaws can be separated sufficiently. Absence of all the teeth is always of advantage in employing per-oral irradiation. When this method can be employed satisfactorily, it seems to be quite advantageous.

In treating cancer of the tonsil the primary lesion and the most frequent site of metastases can be irradiated through a single portal on each side which is a fortunate situation not always encountered with cancer elsewhere in the pharynx.

The supplementary use of gold radon seeds on completion of the protracted external irradiation is very desirable in all cases, particularly those in which the tumor has invaded some of the neighboring tissues, as the soft palate or base of the tongue. One should be careful in the estimation of the dosage and the spacing of the implants and the greatest possible aseptic precautions should be used during the implantation.

Radionecrosis may occur in some cases, but this is not nearly so serious a complication here as in other parts of the pharynx. When this occurs the patient should be seen and treated as often as necessary until the lesion is healed.

Cervical metastatic nodes will often prove to be more radioresistant than the primary lesion and, in such cases, implantation of radon seeds should be performed, preferably by surgical exposure of the node by a short incision, so that the seeds may be implanted more accurately under direct vision and palpation.

In conclusion, I feel that the mode of therapy as outlined by the essayist is logical and offers a better prognosis than any other present-day method of therapy.

DR. MATTICK (*closing*): I want to thank the Society very much for the privilege of presenting this paper. I would urge all the members here to report these cases, I know you must have a lot of them, so that the Society can get a better idea of what the end-results are actually going to be. There has been quite a paucity of statistics on this subject, and I feel such results will be better than generally expected.

BILATERAL HYPERNEPHROMA[1]

By JOSEPH F. ELWARD, M.D., *and* R. LEE SPIRE, M.D., *Washington, D. C.*

FEW pathologic problems offer greater difficulties than the classification of tumors of the kidney. Until little more than a half century ago, these neoplasms were generally divided quite simply into two major groups. The first of these comprised small, potentially destructive tumors of epithelial origin, the gradual malignant transformation of which had been conclusively demonstrated by contemporary pathologists. The second group included small, yellow, apparently benign lipomatoid tumors of the cortex. The identity of the structure of these latter tumors with that observed in cortical hyperplasia of the suprarenal gland was subsequently pointed out by Grawitz (5), who, incidentally, attributed the genesis of malignant tumors of the kidney to misplaced adrenal rests deposited in the capsule and cortex during fetal life.

The initial application of the term "hypernephroma" to this class of tumors is variously credited to Birch-Hirschfeld (2) and to Lubarsch (8), who also referred to them as hypernephroid. A number of prominent pathologists, chief among them Stoerk (11), eventually disputed the hypothesis of the adrenal origin of these neoplasms, and declared their belief that the tumors in question actually arose in tissue of the kidney. More recently, other authorities, Young (14) in particular, have expressed their objection to the designation "hypernephroma," because of the implied assumption of an original derivation from adrenal tissue, and have suggested the substitution of the term "nephroma" as a generic title for all tumors of the kidney, irrespective of their source and location in the latter.

Two forms of malignant hypernephroma have been distinguished. First, there is the typical destructive variety, resembling structurally the zona fascicularis of the adrenal gland, and originating probably from misplaced rests of adrenal cortex in the kidney. Then there is the atypical variety of mixed tubular character, representing perhaps inclusions of renal tissue in the misplaced adrenal portions, although the pathogenesis of a certain proportion of this variety of tumor is still obscure.

Malignant hypernephromas usually exhibit degenerative changes which vary with their extent and rate of growth. Most large tumors present areas of necrosis and hemorrhage, the latter sometimes so profuse as to induce a rapid increase in volume. Resorption of hemorrhagic areas may lead to the formation of large pseudocysts, or a single large pseudocyst may develop in a medullary tumor containing little connective tissue, as a result of necrosis and cystic degeneration. The scirrhous type of tumor, in which the mass is divided by septa of connective tissue into lobules of tumor cells, may reveal a variegated aspect on section. Finally, in consequence of the copious amounts of cholesterin contained in certain cavities produced by necrosis, the dense capsule of connective tissue with its septa extending into the tumorous mass may undergo marked hyaline alteration, calcification, or metaplasia into osseous tissue. These latter phenomena are readily demonstrable by roentgenography, as the case described by Arkin (1) in the monograph cited in our bibliography so admirably illustrates. Here the tumor was discovered by fluoroscopy, and the diagnosis was, in due course, established from the roentgen study and the clinical data. The roentgenograph revealed a distinct calcified capsule and a definite lobulated structure characteristic of a slowly

[1] Read before the Washington Medical and Surgical Society, November 28, 1938.

growing renal tumor of the scirrhous type. The roentgenologic diagnosis of hypernephroma was confirmed by histologic examination.

The classic triad of symptoms of renal hypernephromas, in general, is hematuria, pain, and a palpable tumor of the kidney. All these symptoms may be absent in the early stage of malignancy or in the firmly encapsulated benign type so frequently encountered at autopsy. The malignant character of a hypernephroma may be revealed by the persistent hematuria resulting from the invasion of the renal pelvis or of a calix by the tumor. However, intermittent hematuria is quite often the initial symptom, and distention of the renal pelvis by blood clots may provoke attacks simulating those of true renal colic. Pain is usually referred to the lumbar region, and varies from a dull ache to the severe crises occasioned by obstruction from coagula following gross hemorrhage. A tumorous mass is rarely palpable in the incipient stage, on account of the small size of the neoplasm at that period of its development.

Diagnostic roentgenology offers a reliable means for the localization of renal tumors. Five methods of procedure are available for the purpose, namely, roentgenography of the kidneys; pyelography; pneumoperitoneum; perirenal injection of oxygen gas (pneumoroentgenography), and examination of the colon and stomach for dislocation.

With the first of these methods, large tumors may easily be recognized as a more or less irregular shadow continuous with the shadow of the kidney. On the contrary, small tumors are seldom visualizable, unless calcified.

Modifications in the position, size, and shape of the image in the pyelogram may be produced by a tumor developing in the parenchyma and extending toward the renal pelvis. Here the calices may be compressed to form narrow slits or expanded in various directions, the pelvis being occasionally reduced to a narrow slit or divided into separate compartments. Large tumors may cause ptosis of the diseased kidney. Pyelographic studies are especially valuable for the differential diagnosis of cystic kidney from hypernephroma.

When localization by pneumoperitoneum is intended, roentgenographs are made before and after the intraperitoneal injection of three liters of a mixture of one-fourth of carbon dioxide and three-fourths of oxygen gas. The tumor is usually represented as an opaque shadow. This procedure is especially adapted for the visualization of cortical tumors of the suprarenal gland.

The object of perirenal insufflation is to render the limits of the kidney discernible by enveloping the latter with gas. With the subject in the lateral position, approximately 500 c.c. of oxygen are injected into the lumbar region beneath the twelfth rib, with an appropriate apparatus used for pneumothorax, care being taken to avoid an air embolism. The method is positively contra-indicated in hydronephrosis and acute processes.

An important element in the differential diagnosis between tumors of the kidney and the spleen, respectively, is the fact that renal tumors usually displace the colon anteriorly, while splenetic tumors are situated ordinarily in front of the colon, and displace it slightly or not at all. Accordingly, in the course of the roentgenologic examination of the colon for possible dislocation, marked displacement of the colon anteriorly and inferiorly indicates the kidney, and the absence of displacement the spleen, as the site of origin of the tumor. Splenomegaly (leukemia) may displace the colon in almost any direction, usually downward and to the right.

Roentgenologic differentiation of renal tumors likewise entails the consideration of a number of affections of the kidney which may produce alterations in the roentgenogram. These disorders are principally infections with or without calculi, parasitic diseases, tuberculosis, large hydronephroses, pyonephroses, perinephritis, paranephritic abscess, cystic kidney, and congenital malformations closely resem-

bling neoplasms. Large growths must be carefully distinguished from gall-bladder and splenic manifestations, intestinal tumors, and retroperitoneal masses. Since very large tumors are almost never sharply outlined, an apparently enlarged kidney shadow is not necessarily indicative of a newgrowth, but may perhaps be attributable to physical peculiarities of the patient or to technical conditions.

A modified renal pelvic outline, in the presence of symptoms suggestive of tumor but without external evidence of the latter, may be due to localized invasion of kidney substance and pelvis by a small neoplasm, intrapelvic tumors, or filling defects resulting from spasm, soft calculi, aberrant vessels, etc.

The extent of pelvic deformity ranges from minor involvement of a single calix to complete occlusion, as in renal tuberculosis. However, exclusion of a calix by a tumor is usually complete or the shadow diminishes from pelvis to cortex, while in tuberculosis complete isolation is less common, a partial exclusion revealing narrow fillings more adjacent to the pelvis, with a tendency toward distal dilatation due to the formation of abscesses, a condition which does not occur in tumor.

The possibility of calcification of the kidney in hydronephrosis and pyonephrosis, as well as in perinephritis and paranephritis, should always be borne in mind and, if existent, will facilitate the differential diagnosis by production of a definite shadow. Tumors of the capsule of the kidney—fibromas, myomas, or mixed—may become hyalinized and calcified, and thus also cast a shadow.

Congenital cystic kidney, which is frequently bilateral, may be disclosed by roentgenography, either alone or in conjunction with pneumoperitoneum. The cysts produce distinct shadows or modify the form of the renal pelvis.

Large fused kidneys, horseshoe kidneys, kidneys with double pelves, ectopic and polycystic kidneys may all be confused with renal neoplasms. Of these anomalies, polycystic disease in particular may closely simulate a tumor. Although they are variable, the pyelographic changes exhibited by a polycystic kidney are much more characteristic than those presented by a renal neoplasm, being usually bilateral and marked by extreme elongation of the calices and by absence of the fine linear streaks observed ordinarily in tumors of the kidney.

Accidental discovery of the radiosensitivity of cortical renal tumors induced Waters (12) to undertake a study of the devitalizing effects of pre-operative irradiation in a group of 44 cases of hypernephroma. With 800 r, measured in air, as the skin erythema dose, daily doses ranging from 195 to 345 r were administered at a uniform voltage of 200,000 and with 0.5 mm. copper filtration, the total tumor dose varying between 1,600 and 3,500 r, through three and occasionally four portals of entry. The approximately correct tumor dose was determined from cross-sections made to estimate the location and depth of the tumor. It was observed that irradiation effected a marked reduction in the size of tumors, and thus rendered operable large tumors previously inoperable on account of their size. Moreover, the irradiation produced extensive morphologic changes, including alterations in cellular structure, diffuse fibrosis, hyalinization, and necrosis. Normal renal tissue was not destroyed and operation was not made more difficult by irradiation. However, it was found that re-growth occurred if operative removal was too long delayed.

While instances of the occurrence of unilateral hypernephroma are by no means uncommon, cases of presumably primary bilateral involvement are exceedingly rare. In fact, a thorough search of the literature yielded only four examples.

The first of these cases was published by Chute (4), in 1910. When seen at the hospital, the patient, a man 62 years of age, gave a history of intermittent attacks of painful micturition and hematuria of 12 years' duration. Three successive cystoscopic examinations, conducted during intervals between bleedings, pointed to a

cicatrized simple ulcer of the bladder as the probable cause of the hematuria. Exploratory laparotomy was followed by death within 48 hours. At autopsy it was found that the left kidney had been invaded and replaced practically in its entirety by a newgrowth. The right kidney revealed a hypernephroma limited mostly to the suprarenal region (upper pole) of the organ. The area mistaken for a healed ulcer proved to have been formed by a metastatic hypernephroma of the intestine which adhered to the wall of the bladder. A small metastasis was discovered lower down in the intestine. Attacks of hematuria and intestinal metastases were believed to have originated from the growth in the left kidney which was, like that of the right kidney, assumed as primary and independent.

In a case reported by Weber (13), in 1915, a male patient, aged 49, on admission to the hospital presented a distended abdomen with marked enlargement of the superficial veins over the latter, and edema of the legs, resulting from a blow in the right side sustained eight months earlier. The urine contained a trace of albumin, some erythrocytes, and granular tube casts. At the end of four weeks a comatose condition set in, with subnormal temperature and almost complete anuria. Death occurred on the third day of uremic coma. Autopsy showed that the suprarenal glands and kidneys on both sides of the body were infiltrated with malignant hypernephroma, with secondary nodules of the newgrowth in the liver and lungs. Venous thrombosis, arising probably in veins of the enormously enlarged left kidney, involved both renal and both hepatic veins and the whole inferior vena cava, the clot extending continuously from the iliac veins below to the heart above, the upper end of the thrombus projecting into and partly occluding the right auricle. Close to the heart the clot was infiltrated secondarily by the malignant tumor. The final practically absolute suppression of urine was attributed to complete venous thrombosis of the less seriously diseased right kidney.

Kinney (7), in 1927, contributed a third case in a man, aged 45, who, one year previous to entrance into the hospital, had experienced an attack of comparatively severe but painless hematuria, which continued for two or three days. Three weeks prior to admission, he suffered severe pain in the left loin, followed by profuse hematuria. Some tenderness over the left renal area and a palpable mass corresponding to the kidney on the same side were noted on physical examination. Left pyelography revealed considerable deformity at the left renal pelvis and calices, and a filling defect suggesting a newgrowth rather than an infection. Right pyelography two weeks later showed a marked irregularity in the outline of the pelvis and calices of the right kidney, presenting the characteristic aspect of a hypernephroma. Both kidneys were enlarged and apparently in the same condition. Since an operation was contra-indicated by the pyelographic evidence, rest was advised. When heard from again nine months later, the patient complained of increased pain over each loin on exertion.

In the same year Hunt (6) reported a case observed in a male patient, aged 65, who came to the hospital with an hematuria which had persisted with brief intermissions for ten months. He complained of occasional dull pain in the area of the right kidney. A mass was palpable in the left renal area. In the pyelogram of the left kidney the upper calyx was obliterated and the pelvic outline irregular. A tentative diagnosis of left renal neoplasm (probably hypernephroma) was made. Nephrectomy was performed and a large hypernephroma involving the upper half of the left kidney, with metastases to the left suprarenal gland, was removed. Death from general peritonitis and ileus secondary to gangrene of two loops of small intestine occurred on the fifth post-operative day. A somewhat smaller hypernephroma of the right kidney was found at autopsy. The simultaneous presence of hypernephroma in both kidneys was regarded as a coinci-

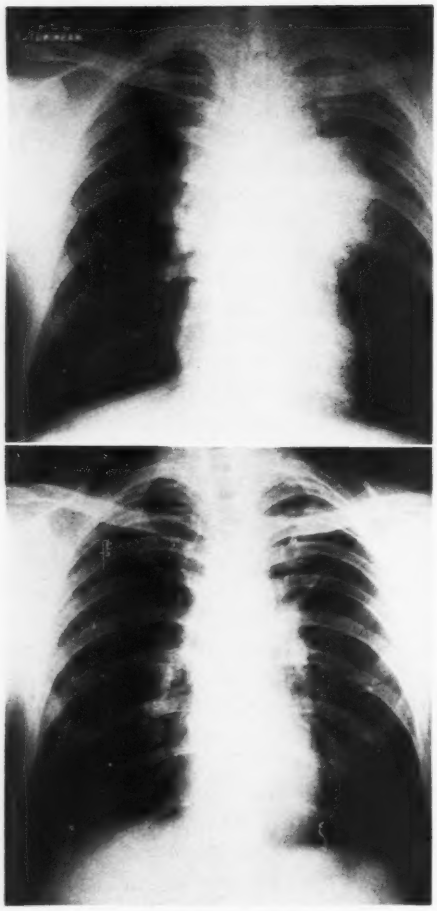

Fig. 1. Case 1 (*above*). Mediastinal tumor on March 13, 1935. Before irradiation.
Fig. 2. Case 1 (*below*). Mediastinal tumor on May 20, 1935. After irradiation.

dence and without relationship in respect to possible metastasis.

To the above case we add the following one which has certain unusual features—principally, the lack of subjective symptoms referable to the urinary tract, the absence of positive findings on pathologic examination of the urine, the apparently rapid metastasis to the mediastinum with localization of symptoms at this point. The rapid response to roentgen therapy is of secondary importance in that lymphoid and highly malignant tissues (nephromas) are markedly radiosensitive.

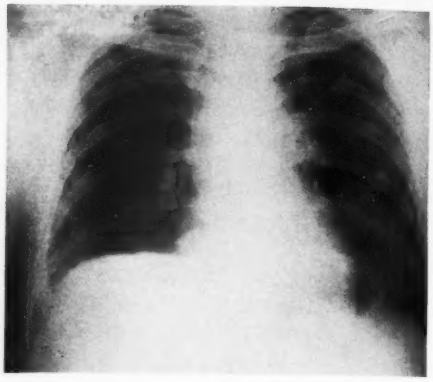

Fig. 3. Case 1. Mediastinal tumor on Nov. 14, 1935, showing recurrence with extension into lung parenchyma.

E. J., white male, married, aged 36 years, salesman, was first seen (R. L. S.) on Feb. 12, 1935. He complained of a fullness of the neck when leaning forward. This sensation, first noticed two weeks prior to this time, was slight at first but became increasingly annoying.

Physical examination was completely negative; his blood pressure was 124/78; the heart and lungs were apparently normal; the hemoglobin was 82 per cent; the urine negative, and the diagnostic impression at this time was possible angioneurotic edema.

Examination on Feb. 19, 1935, was again negative except for fullness in the neck which was evidenced when leaning forward.

Examination on Feb. 25, 1935, showed considerable swelling of the neck, marked redness of the face, and edema of both upper and lower eyelids.

Physical examination on March 8, 1935, showed an area of dullness to the right of the sternum at the level of the third and fourth ribs anteriorly. At this time there was also marked congestion of the superficial vessels over both pectoral areas. The patient stated that he had noticed this congestion on several occasions but that it had lasted over such a short time that he neglected to mention it. At this time a diagnosis of a mediastinal tumor was made

and the patient was referred for x-ray treatment.

X-ray examination on March 13, 1935, showed a mediastinal newgrowth, probably lymphosarcoma. X-ray treatment was instituted immediately and covered a period from March 14, 1935, to Nov. 15, 1935.

An x-ray study of the chest, made on April 8, 1935, showed the mediastinal mass markedly reduced in size. There was almost complete disappearance of the symptoms. The patient resumed employment.

On May 20, 1935, examination showed almost complete disappearance of the mass. The patient was symptom-free and pursued his usual employment.

An x-ray study made on June 8, 1935, showed residue of the mediastinal newgrowth but no progress. Symptom-free. Usual employment.

An examination made on July 10, 1935, showed no change from the examination on June 8, 1935. Symptom-free. Usual employment.

On Oct. 1, 1935, the examination showed some slight increase in the mediastinal shadow as seen in previous examination. There was recurrence of symptoms.

On Oct. 16, 1935, there were apparently no changes from the previous examination made on Oct. 1, 1935.

On Nov. 14, 1935, examination of the chest showed recurrence of the mediastinal tumor, with some involvement of both lungs but no evidence of involvement of the skull or bony framework.

The patient was in excellent condition from April, 1935, to October, 1935, when he began to lose weight and had considerable nausea, believed to be due possibly to x-ray therapy. At various times he was given liver extract intramuscularly and glucose intravenously but the progress was downward and the patient was last seen on Dec. 1, 1935. At this time he was sitting up in bed complaining of shortness of breath; both hands were markedly swollen and edematous, while the arms were swollen to a lesser extent. Death occurred on Dec. 8, 1935.

RELEVANT AUTOPSY FINDINGS

Kidneys.—The left kidney is markedly enlarged; it measures 17 cm. in its longitudinal diameter by about 10 cm. transversely; it is incorporated with the adrenal gland into a more or less indistinguishable mass which involves the spleen, pancreas, and retroperitoneal tissues and the gastrolineal and renalineal omentum. On section, the kidney architecture is more or less obliterated by the neoplastic mass and only remnants of the nephritic tissue can be found. The right kidney and adrenal gland are more or less obliterated also by the confluent proliferative neoplastic mass which is somewhat spread through both organs. The architecture of the adrenal is completely obliterated, whereas only portions of the kidney parenchyma can be found. Into this mass on both sides is demonstrated the entrance of vessels and the exit of ureters. The ureters are somewhat thickened in their proximal portions but do not exhibit any evidence of hydroureter.

Lungs.—The right lung is free in the pleural cavity. There is a moderate amount of yellowish colored fluid present. There are a few old puckered scars in the apex. There is a moderate amount of anthracosis present. A number of small shot-like neoplastic nodules are scattered throughout. In the region of the hilum there are marked adhesions to the mediastinum and pericardium, with evidence of pronounced fibrosis, probably resulting from deep roentgen therapy. There is a well defined terminal hypostatic congestion and edema.

The left lung is free in the pleural cavity, except in the apex and in the region of the hilum, and presents much the same picture as that of the opposite side, with well defined terminal hypostatic congestion and edema. In the region of the hilum there are massive adhesions with an extensive amount of neoplastic newgrowth tissue binding the lung tissue to the pericardium, great vessels, esophagus, and trachea. The lymph nodes in this region are ex-

tensively infiltrated and enter into a large conglomerate mass.

Heart.—The heart is small, and surrounded by a thickened pericardium which shows evidence of a fibrinous pericarditis. The base of the heart is embedded with the lungs are obliterated by the rather extensive mass described above.

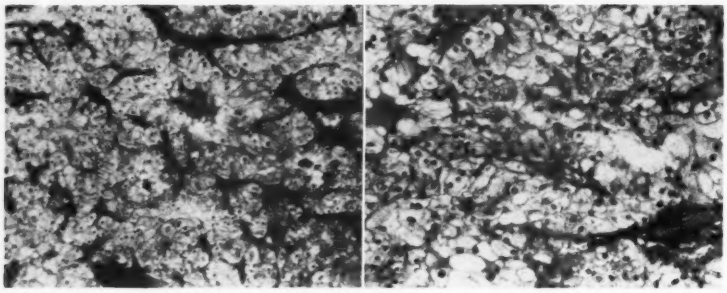

Fig. 4. Fig. 5.

Fig. 4. Case 1. Section of kidney tumor (× 280).
Fig. 5. Case 1. Section of kidney tumor (× 605).

roots of the great vessels and hila of the lungs in a mass of neoplastic tissue which shows a marked degree of fibrosis, apparently from roentgen therapy.

Microscopic Examination.—Sections from the abdominal mass show the same to consist of large irregular types of cells, atypical in arrangement and structure, but tending to form circular groups in certain instances and cord-like structures in others. The cytoplasm of the cells is somewhat granular, contains fat-like globules, with evidence of degenerative changes. The supporting connecting tissue is quite variable; there is marked round-cell infiltration accompanying the neoplastic proliferation. Sections from the kidneys reveal much the same picture, with marked diffuse infiltration of round cells and the presence of an abundance of large irregular neoplastic cells, obliterating the renal architecture and adrenal glands.

Sections from the lungs show marked hypostatic congestion and edema, many of the air sacs being filled with blood and serum; the presence of interstitial fibrosis; varying degrees of anthracosis, and a number of shot-like neoplastic nodules. The mediastinal glands and the hila of the

ANATOMIC DIAGNOSES

1. Hypernephroma bilateral, with extensive involvement of the pancreas, adrenals, kidneys, and all retroperitoneal structures at this site.
2. Multiple metastases with extensive involvement of the mediastinum, roots of both lungs, with evidence of marked retrogression at this site, apparently from roentgen therapy.
3. Chronic interstitial hepatitis with toxic changes, including cloudy swelling, fatty infiltration, hypostatic congestion, and neoplastic invasion.
4. Chronic interstitial and perisplenitis with marked hypostatic congestion.
5. Partial neoplastic obliteration of the pancreas, adrenals, and kidneys, with extensive cloudy swelling and parenchymatous degeneration.
6. Chronic myocardosis with interstitial proliferation, granular degeneration, pigmentation, fibrinous pericarditis.
7. Terminal hypostatic congestion and edema of both lungs.

SUMMARY

A case of bilateral hypernephroma is added to the literature. The classification of renal tumors is discussed as is their radiosensitivity, symptomatology, roentgen diagnosis, and roentgen therapy. The

case discussed presented no subjective symptoms referable to the genito-urinary tract, metastasized early to the mediastinum where all symptoms seemed to originate. The metastases responded rapidly to roentgen therapy and almost as rapidly became radioresistant. The outcome was fatal. Autopsy findings are included in the report.

The possibility of cancer of a so-called renal rest of the mediastinum with metastases to both kidneys must be considered.

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PHYSICAL DOSES AND BIOLOGIC DOSES[1]

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A FUNDAMENTAL essential for any therapeutic prescription is the qualitative and quantitative evaluation of the physical means used and of the reactive effect which takes place from it in certain vital elements. Now, the physical and biologic study of these important problems is quite complete but is still inadequate to establish exact normals of therapeutic technic. Even if the physical definition of the quality and quantity of radiation used can be considered within limits sufficiently exact, the status of the study of their application according to which the energy submitted is transformed in the absorbing media, because the mass of living tissue submitted to radiation is very complex and unhomogeneous. There exists, in fact, in the computation of the factors inherent in the radiobiologic problem a quantity of extremely variable factors, as a result of which it is extremely difficult to establish a valid relationship between the quantity of radiant energy administered, and the reactive effect produced in the irradiated organism.

Taking under examination our actual knowledge by which a physical dose may be defined in relation to its biologic effects, it is observed, first of all, that not only is the evaluation of biologic radio-activity even now completely arbitrary and based on empirical foundations, but also that the physical dose, as we understand it, as being the quantity of radiant energy administered and absorbed in the depths of the tissues cannot in reality be defined exactly either. If we admit that the physical measurement of a beam of radiation can be defined for all practical purposes qualitatively by its half value layer and quantitatively in international r units, and even admit that the measurement in r units may be carried out with very exact methods but still not definable in absolute terms, we still have the problem of defining exactly the quantity of energy emitted from the x-ray tube or from whatever source of radiant energy; we still do not come to a point where we can define the modality of the emission of the radiant beam itself in relationship to the characteristics of the high tension generating system to the properties of the beam so produced, to the distribution within the beam itself of the energy which composes it, and to the variations in the qualitative proportional relationships which may take place in the beam of radiation during a definite period of its emission.

The definition of the international r unit implies special conditions which theoretically are important in defining exactly the quantity of energy physically but which cannot under ordinary conditions of application be carried out to the letter, nor does apparatus which is in theory sufficiently precise in regard to the fundamentals by which the r unit is to be defined, give a value really exact and constant for the radiant energy which is measured. Therefore, any measurement which is ordinarily carried out should, of necessity, be considered as a relative one, even if the standardization of the measuring devices used may correct to the greatest extent the causes of error which, in the measurement of r, are actually present in the quantitative physical determinations.

Neither does the measurement of the half value layer suffice to define the quality of a beam of radiation, a unit which has

[1] Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13–17, 1937.

been proposed by the International Commission to define the quotient of homogeneity of the beam itself, because that unit varies with the hardness of irradiation. Therefore to define this exact qualitative value we must take into account in our computations the relationships of the voltage, the filtration and the half value layer and the homogeneity-quotient, factors which for many reasons cannot be held constant under normal conditions of operation of the ordinary generating system. Nor does the value of lambda average, determined from the relationship between lambda maximum and lambda minimum as found by spectrograms, correspond exactly to the real qualitative characteristics of the beam of radiation in relationship to the possible quantitative difference of the individual beams which lie between the lambda maximum and the lambda minimum.

If we admit that for all practical purposes the r unit measured by ordinary ionometers and that the half value layer furnish values adequate to evaluate the radiant energy emitted by a given radio-active source, we must keep in mind that such values are insufficient to define the actual "dose" of radiation which is given, and which is distributed in the irradiated body. Even though it is possible to define by them the quantity of energy emitted by an x-ray tube or by a radio-active preparation with sufficient exactness, and by them to define a physical dose incident on a body subject to irradiation, they are not sufficient to determine the quantity of energy which is absorbed, and the modality according to which it is distributed and transformed in any given absorbing medium.

In this regard it is to be remarked that the ionization chamber of the ordinary ionometers do permit the estimation of the quantity of ions which are liberated by the action of x-rays in a definite quantity of air: from many studies made on this point by Glasser and Fricke there has been reported a relationship between the phenomenon of ionization which takes place in the air and that which is produced in living tissue which, from their studies, is a constant (1/830). Now such a relationship can exist only within wide limits because with the varying quality of radiation which excites the phenomenon of ionization in the different absorbing media there exist marked variations which modify very definitely any comparative values. In spite of the fact that various atomic components of tissue have atomic numbers similar to those of air, in the make-up of organic elements, they occur in a higher percentage (11/100 of the total weight of the body, 64/100 of complex atoms): hydrogen has an atomic weight much lower and has a coefficient of dispersion much higher, so that all evaluations of the relationships with a variation of wave length of the exciting wave are complicated.

The attempts to substitute in the air ionization chamber mixtures of gas with an atomic number corresponding more exactly to that of the tissue have not as yet reached any possibilities of practical application. Under actual conditions the ionometric method, even though it is precise physically, does not furnish any real means of determining the effective dose absorbed in the tissues to any absolute value, and that situation is made more difficult because of the heterogeneity of the media of which living tissue is composed.

Physical studies on distribution of radiant energy, in fact, may define the quantity of energy which reaches a definite point in the depth but they do not permit determination of the real quantity of energy absorbed and transformed at that point; neither by control of the relationships between the incident dose and the emergent dose in the given irradiated mass is it possible to determine the effective dose administered to the mass itself with reference to the multiple variables inherent in the spacial distribution and in the make-up of the incident beam, factors which become more complex when we attempt to refer the experimental data and measurements to the heterogeneous and changeable complex which constitutes the human body.

Theoretical and experimental studies on

the properties and characteristics of absorption of radiation in absorbing media of varying natures, homogeneous or not, have shown by many recent observations that absorbed energy behaves independently of the multiple and complex biologic factors in a very varying way in relation to the quality of the radiation applied, to the distribution of radiation in the absorbing mass, the time factor to the true coefficient of absorption per cubic centimeter of the substance irradiated. We must assume, then, in the evaluation of the quantity of energy absorbed in addition to the value in r of the energy administered and of the half value layer, those factors inherent in the homogeneity of the bundle, the size of the field irradiated, the distance intervening between the radiating focus and the surface of the body irradiated, the directional coefficient, and so forth, by which the distribution of an incident dose is variably transformed into an effective dose. These factors entering into theoretical and experimental studies in the *Wasserphantom* or in the paraffin block, can be determined with enough precision to enable us to establish exact isodose curves for single layers in the depth of a homogeneous mass, but in the case of the human body, because of its different constitution, we meet special difficulties of measurement and these alter definitely the relationships which are given in the diagram of the distribution of radiation in the depths. From control measurements carried out by many authors and by myself, it has been demonstrated that in media made unhomogeneous artificially and from direct experiments on the cadaver and on the living, the effective distribution of irradiation in the mass of tissue behaves irregularly according to structural differences of the various segments which make up the irradiated body. So it happens that the evaluation of the effective doses administered at the depth changes definitely from case to case, from the values given in isodose curves made up from calculation or from measurement in the homogeneous mass of the "water phantom" or the experimental block of wax.

The quantitative evaluation in r of the effective dose can, therefore, not be defined exactly merely by the measurement in r of the incident dose, simply because the complexities and the variation of the factors which go to make it up, and that fact should be considered in the qualitative estimation of the half value layer since this is also based on measurements of quantitative comparison which are susceptible to various causes of error. It results, therefore, that for various reasons inherent in the genesis of the beam of radiation itself, in the method of measurement, in the modality of the measurements it is difficult to establish for practical therapeutic applications an exact relationship between the incident dose and the effective dose, and that situation becomes more difficult if it is desired to establish relationships between the physical dose and biologic dose, assuming whatever quantitative value we wish for the reactive effect in the mass of living tissue irradiated. Even though we admit that the incident dose of radiation has been determined exactly by physical means, each possibility of establishing a relationship between the physical dose and that effective in the mass of tissue irradiated becomes very difficult. The causes of error in the evaluation of the absorption and transformation of the instant energy are definite and become complicated and multiplied in living tissue on account of very many other factors, so that every pharmacologic value of the physical dose must be made by experimental and practical biologic criteria.

The theoretical, experimental, and clinical questions inherent in the possibility of determining the biologic dose are so numerous and complex as to render hypothetical and empirical any quantitative therapeutic dosimetry whatever. That is due partly to reasons strictly belonging to the biologic phenomena, partly inherent in the essentially clinical causes from the multiplicity of the pathologic manifestation itself.

Among the most important factors in the evaluation of the reactive biologic

effect is the time in which radiation is administered, a factor which in the definition of physical dose has no effective value but which in the definition of the effective dose is important on account of the well known law of Bunsen-Roscoe, according to which equal products of intensity and time produce an equal photochemical effect. In the living organism, on the contrary, the modality of absorption of a physical dose presumed constant has been shown to be entirely different according to the fractionation which this quantity of radiation may undergo in relation to the modality of the irradiation.

Numerous practical experiments in this regard have shown, particularly in recent years, how great an importance the time factor takes on in the determination of the reactive dose and of the biologic effects. It has been shown, in fact, that the dissipation or the cumulation of a given biologic effect is subordinate to special conditions, according to the extent to which the cellular elements show a "recuperative effect" which is independent of the phenomena of reversibility or non-reversibility of the radiation injury of the cellular elements and which determine marked variations in the complex effect of the reaction to a physical "quantum" of radiation dose applied. On this point the most recent observations of the Italian radiologic school seem to be particularly interesting, for example, the experimental researches of Milani on "ervum lens"; of Turano on old and young cultures of *B. coli;* of Bellucci, Nicotra, Vallebona, Palmieri, and others on cellular elements of varying nature, have shown that the physical dose, considered as definite, is, from the standpoint of its biologic effects, really dependent on most variable conditions, among which the time factor is of so great importance that the radio-active phenomena cannot be compared in any quantitative way nor can the photochemical phenomena according to the law of Bunsen and Roscoe, and of Schwarzschild have an absolute value. This is more so because the biologic changes are not an expression of the action of the physical agent employed but, on the contrary, are the reaction of the living elements to the radiation itself. The radiant energy which in a physical dose is effective in a body subjected to irradiation may be considered, as has been said, effective not in a quantitative relationship with its absorption but with the modality with which it is transformed in the material itself. Now this transformation in the living cellular elements which represent in their complexity a great quantity of very different and unstable elements, and which by their nature and in their relationships behave so very differently, not only by their varying molecular anatomic equilibria in their vital cycles but also with respect to the modality itself, by which the energy reaches the structure of the irradiated elements. This essential reactive factor of the living elements varies with the time of irradiation and, therefore, the reactive effect is valid for a certain dose at definite time of the vital cellular cycle to which corresponds the optimum of reaction, a reaction which cannot be considered only from the cytolitical manifestations of the element irradiated but from all the other biochemical and biophysical phenomena, known or unknown, which make up and determine the radiosensitivity of the element itself.

On the other hand, in the elements irradiated the possibility of recuperation is most variable, not only in respect to the "moment of irradiation" but also in dependence on the modality by which the elements have been irradiated or, more precisely, on the duration and subdivision of the physical dose which has been administered. The experiments of Bellucci on this point have shown that the physical laws hold for the radiation, but in the case of the same stimulus applied with varying frequency the biologic response may appear completely different.

Experimentally, in fact, it has been demonstrated that according to the frequency with which the vital element in a determined time of irradiation is submitted to the irradiating stimulus, the most ef-

fective action corresponds to a quantum of fractional irradiation administered in one second. For the skin, such an optimum is about fifteen exposures; this experiment, capable of other control changes, may nevertheless give new possibilities of studying the relationship between the technical modality and the therapeutic indications to produce a maximum biologic reactive effect from a quantum of physical dose administered. Other important factors may also come in to make more complicated and indefinite the studies of the exact definition of the biologic dose which has been administered. We must in this respect take into consideration the multiple questions inherent in the radiosensibility of the cellular elements, from which it has been shown that not a small portion of the problem of reactivity may be due to the pericellular complex, shown by Schwarz and others thirty years ago on the material exchanges of the surrounding medium in relation to the intensity of the stimulus and the special conditions of radioresistance of the elements, both normal and acquired. On this point no dosimetric data can establish how inappropriately the acquired radioresistance of the determined element has been defined in the evaluation of radiovaccination. These energy phenomena which may be the manifestations of diminished reactive capabilities (hypoergia, anergia) or in some cases the manifestations of hyperergia, are in reality determined by processes analogous to those which many toxic agents produce in the body. Even though no experiment has shown an immunobiologic effect, it has been possible to demonstrate that there exists in the serum of the blood of persons irradiated a foreign proteinic condition caused by the terminal protein breakup by which there had been produced local or generalized toxic states which, nevertheless, have no characteristic organic reactive properties as do other toxic products giving greater resistance to the element exciting it. There is no specific radioresistance to irradiations, but it is generally recognized that there is an organic radioresistance in the tissues pre-irradiated by which the limits of reaction to the physical dose are elevated toward the upper normal reactive limit, depending on a selective process which in normal and pathologic elements stabilizes itself in such a way as to determine in the decrease of the cells a progressive radiorefractoriness in which there are concurrent involutive changes in the connective tissue, as the result of which the phenomena of organic change and the re-establishment of cellular equilibrium are gravely compromised. In particular, the radioresistance of cellular elements previously irradiated is not a phenomenon due only to the possibility of recovery of the cellular element irradiated, but is an effect essential to the radiorefractoriness of the irradiated organic complex in which there takes part not only the irradiated cellular element which has an acquired property of cellular selection which is transmitted to the descending cells by a mutation effect, but also the surrounding medium through an involutive process in the vascular connective tissue surrounding it which inhibits, even though they are accompanied at times by an inflammatory process, the possibility of repair of the element injured by irradiation. These phenomena of radioresistance seem in each case essentially local and such as thereby to exclude the possibility of a generally acquired radiosensitivity, even though this has been defined by some authors as similar to an immunitary effect, especially from considerations of the reactive biologic dose in relation to different technical modalities of administration of a constant "quantum" of dose, the effect of which is known. There exists, nevertheless, in a criticism of the evaluation of the biologic dose important elements which from the standpoint of time, the effective quantity of the dose absorbed, the reactive cellular phenomena may take on a special importance in the definition of the modality of radiologic cellular saturation. In other words, the definition of the quantum of energy necessary for cellular destruction is made up of multiple factors which carry the element

to the limit of irreversibility of effect, and to which is added the possibility of metabolic repair of the injured element. The experiments of Kingery, of Holfelder, of Pfahler, of Nicotra, and others, have shown that for determined definite doses qualitatively and quantitatively fixed there is the possibility of dissaturation of the irradiated elements according to logarithmic curves of mass reaction similar within certain limits to those which are seen in other chemical phenomena. The curves of saturation which Kingery and Pfahler have deduced from multiple experiments on cutaneous reaction have shown that there exists in reality a summation of effect by which important variations are determined that are not referable to the quantity of the effective physical dose applied.

In reviewing the subject of saturation there is the biologic impossibility of establishing a test for reaction independent of the multiple and various factors inherent in the medium surrounding the element irradiated. The dosimetric evaluation of biologic reactions in cellular elements *in vitro* or in common isolated elements such as eggs of *Ascaris*, the frog, of *Drosophila*, of *Lucilia sericata*, etc., which have been carried out by many experimenters and especially by Krönig and Friedrich, Holthusen, Francis Carter Wood, Glasser, Mallet, and others, based on the portional count of injured and sound elements produced by a definite physical dose determined qualitatively and ionometrically, cannot be regarded as absolute in any way because of the multiple causes inherent in the irradiated element and of external causes in the medium with which the element itself is surrounded. It is not possible, in fact, in any reproducing species to have constant elements, because of their different and variable points of origin and also on account of differences in the surrounding medium, differences in temperature, humidity, latent periods, and so forth. Therefore, any biologic dosimetric definition whatever which may be deduced therefrom is purely arbitrary. This becomes more evident if one wishes to compare the data deduced from percentage computation of destroyed ova to effects on the normal or pathologic tissue complex which makes up the human body, especially since the physical and biologic factors essential to the reactive phenomena are so complex in the mass of tissue irradiated as to render any establishment of relationship of action carried out on an isolated cellular element absolutely arbitrary and inadequate. These many researches, even though they have not up to date furnished an efficient method of biologic dosimetry, have nevertheless put in evidence many facts of special value. In particular, the recent researches of Mottram, Mendolesi, Reverberi, of Alberti and Pollitzer, and Langerdoff are interesting for they have shown particular differences in the sensitivity of cellular elements corresponding to definite biologic systems. According to them there exists for each cellular element, either considered by itself or in its biologic complex in the tissue, moments of radiosensitivity corresponding to periodic alterations, depending on a vegetative rhythm such as has been shown in other fields, by the complex vital reactions of cellular elements or by the organism as a whole. According to this, there exists for the cellular element a rhythm of radiosensitivity by which is determined "a moment of irradiation" proper to the cellular elements in relationship to their vital activity and not dependent on elements of other nature or on conditions in the surrounding medium. Therefore, the study of biologic dosimetric relationships becomes even more complicated and it seems arbitrary to attempt to refer to a single biologic test therapeutic indications for practical clinical application. This applies not only to dosimetric evaluation on cellular elements *in vitro* or on isolated ones, with reference to the complex organic tissue which makes up the human body, but also to the approximation of the cutaneous reactive phenomena which have been selected for ordinary practical radiologic dosimetry. The value of the erythema dose, therefore, because of many physical and biologic

considerations, is inadequate to be a definite basis of reactive measurements. In fact, on the basis of the preceding considerations every attempt at qualitative and quantitative evaluation falls down when either the factor of time or the quality of the radiation used is modified, even though the total physical dose remains constant; but the reaction itself is variable when, for many cases, both known and unknown, the conditions of receptability of the cutaneous tissue or of the complicated organism become changed from any local reactive process. Since it has not been possible to define with exactness the cutaneous manifestations which may be considered as the erythema dose—and that is due to the difficulty of evaluating singly the reactive gradients and the other multiple variations which depend on age, sex, site of irradiation, and so forth—any evaluation of the physical dose in the case of this cutaneous reaction seems subordinate to causes even more complicated, and which recent observations seem to put in evidence from the modality of irradiation the quality of radiation used, the total dose administered, and the intensity r/min. employed.

It seems—from recent knowledge, both experimental and clinical—that the response of the irradiated skin varies with the minimum wave length applied and with the time of its administration and that it is impossible to establish an effective quantitative relationship to the physical dose which has been given.

There are in the evaluation of the erythema dose or the epilating dose or that for radio-epithelitis differences sufficiently important to establish for each one relationships to the physical dose which are totally different quantitatively, so that the definition proposed seems inaccurate and personal to the various authors who have discussed the question.

Particular consideration should be given to the researches of Holthusen on the phenomena of reactive latency and of cutaneous saturation in relation to those of other tissues, and also to those of Regaud and Nogier, of Coutard, and, in Italy, of Turano, of Salotti, and others, who have shown that, depending on the modality of irradiation, the limits of erythema and of tolerance vary, and, as the observations of Mutscheller have shown, the power of cutaneous reversibility is such as to permit within certain limits, calculated to be about 0.04 r an hour, an absorption of radiation without any perceptible evidence of reaction. This index of tolerance, variable according to the special individual receptability, also varies markedly for various tissues, the radioreaction of which cannot be compared in exact terms—dependent on factors of quality and time of the physical dose administered with that of the skin. It seems a precluded fact, therefore, that there is the possibility of establishing a standard on which to base the effective biologic dose with reference to cellular elements or to tissues subjected to irradiation since we cannot establish any dosimetric definition based exclusively on a definite reactive effect of a definite organic tissue at a definite moment or condition of its vital cycle.

Since, for all practical purposes, it is not possible to state the terms for the definition of a biologic dose, even in its broadest sense, it is most convenient for practical purposes to establish the physical data, whatever they may be, and the essential biologic facts to which it is necessary to refer in order to express any comparative value of radioreactions. This is so because the knowledge of the multiple factors inherent not only in the quality and quantity of the incident radiation but also in the total or fractionated time used, in the modality of the subdivision of the dose measured in r, in time and space, in the field factor and in the distance factor. These factors can all be defined with approximate exactness and serve to indicate the quantity of energy administered in a given moment, but with this concept it is not possible to express really the biologic dose insofar as there will always remain multiple involved problems which are inherent in the consideration of a coefficient of radiosensitivity which, no matter how

the relationships of the local and general biologic factors are expressed, cannot be defined in fixed terms, not only in the case of a complicated organism such as the human body but also for the experimental field where isolated cellular elements may be submitted to various experiments. The incident physical dose, quantitatively determined and measured in percentage of progressive absorption in the depths, does not measure the intimate process of transformation which takes place in the irradiated tissue, but expresses in reality only a quantitative datum of the energy administered which in the evaluation of reactive effects has a value analogous to that which the specifications of a dose of a medicine has in the clinical study of a pathologic process.

Therefore, there does not exist in the actual conditions of our knowledge of the multiple reactions in the radiobiologic phenomena the possibility of establishing valid relationships between physical and biologic doses nor is it, in fact, possible to establish physical dosimetric values applying to selected reactive effects or to establish arbitrarily precise indications for therapy or to allow easy deductions of theoretic value which might be subject to adequate control. Nevertheless, the determination of the physical constants is of fundamental importance in fixing the limits of therapeutic applications of radiation but, no matter where future research may establish these values, the many and variable phenomena which radiant energy evokes in tissue will be the deciding factors for an adequate and suitable biologic dosimetry.

CARDIOVASCULAR DYNAMICS[1]

A ROENTGEN KYMOGRAPHIC STUDY

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SINCE the discovery of the circulation of the blood by Harvey, various methods have been developed for the study of the dynamics of the heart and vessels. One of these is the kymographic method, designed automatically to record the function of the organ which manifests itself by a series of outward movements. Such movements are frequently so minute and rapid that their details cannot be discerned by the naked eye.

The discovery of the x-ray permitted direct observation of the action of the heart and great vessels by means of the fluoroscopic screen. Its usefulness was at once universally acknowledged but it was evident that its value would be greatly enhanced were a permanent record of the pulsations obtained instead of only a temporary visual impression. In order to solve this problem, roentgenologists have sought ways and means by which to combine successfully the kymographic principle with the x-ray so that tracings of cardiac and vascular pulsations could be procured for more precise and detailed study.

The first to introduce such a procedure was Sabat (1), in 1911, and Gott and Rosenthal (2), in 1912. Their apparatus consisted of a lead sheet, with one or two horizontal slits, which was placed between the chest and a loaded film, either the lead sheet or film moving at right-angles to the x-ray beam during the x-ray exposure. The developed film showed a tracing of the pulsations of a segment of the heart or vessels. In 1916, Crane (3) so improved the mechanism of the kymographic apparatus that he was able to obtain more satisfactory tracings of various lesions of the heart and great vessels. In 1928, Stumpf (4) introduced the multiple slit kymograph which made it possible to secure a record of the pulsations of the whole heart and great vessels on a single film. Since then, great progress has been made in the improvement of the apparatus and the interpretation of the kymographic records, in which Americans have played a large part, especially Hirsch (5) and Scott (6), with their associates.

For the purpose of completeness, a brief description of the mechanism of a modern roentgen kymographic apparatus will be presented. The apparatus consists of a metal grid, usually a sheet of lead perforated by horizontal slits which are parallel and equidistant to each other. The distance between these slits is 12 mm. and the width of the opening is 0.4 mm. The lead grid is between the patient's chest and the loaded cassette. By releasing a lever the cassette is made to move from above downward at a uniform speed in a direction perpendicular to the slits during the x-ray exposure. The length of the exposure is regulated by a suitable adjustment of the instrument, which is usually set for from one to two seconds. During the exposure the patient is instructed to stop breathing, either in the inspiratory or expiratory phase. The purpose of moving the cassette is to prevent the superimposition of the different phases of the cardiac movements upon one another. The distance travelled by the cassette is only 11 mm., leaving 1 mm. of the sensitive surface protected by the lead bars. When the film is developed, the unexposed surface of the film remains white, so that the surface of the film is divided by parallel white

[1] Presented before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11–15, 1939.

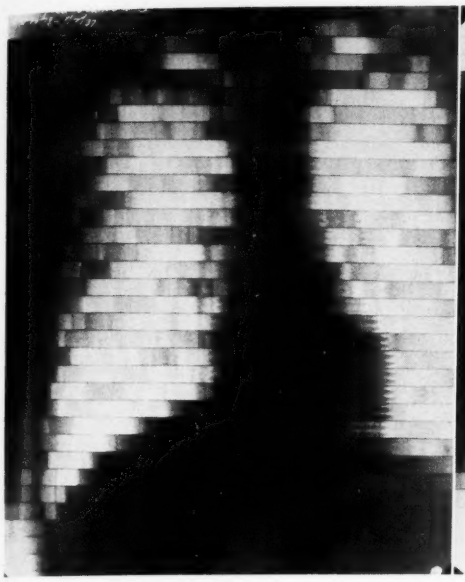

Fig. 1

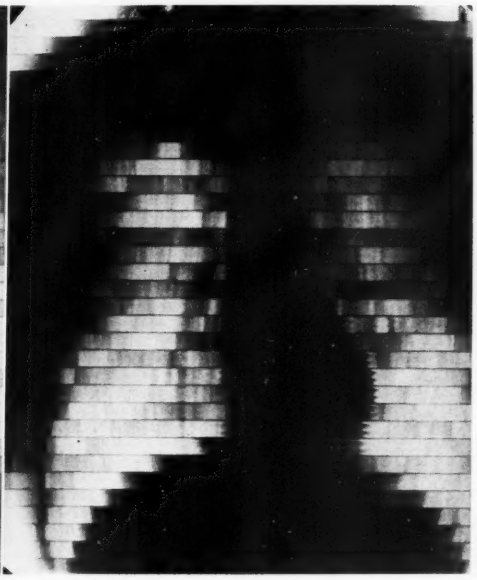

Fig. 2.

Fig. 3.

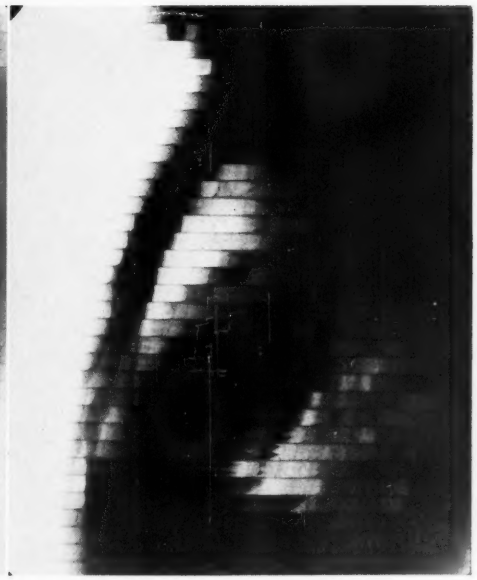

Fig. 4.

lines, 11 mm. apart. Each segment of exposed film between two adjoining white lines is called a frame. At the periphery of each frame are waves, varying in form and amplitude, which are due to excursions of the border of the heart and vessels

during the contraction and relaxation of the cardiovascular chambers. The waves within one frame represent the movements of a single point on the cardiovascular border which happens to lie opposite a slit, while that which remains behind the lead bar is not registered; however, this does not prevent one from obtaining the general outline of the heart and great vessels. Since only those cardiac and vascular excursions are recorded which are parallel to the slits, movements which take place in other directions are not registered. When there are no movements at all along a certain segment of the cardiovascular border, there will be no waves recorded, the border being represented only by a line perpendicular to the slits.

Before a discussion of the roentgen kymogram is undertaken, it might be well to review some of the anatomic, physiologic, and pathologic facts concerning the heart and vessels.

The heart consists of four chambers, two atria and two ventricles, which, together with the roots of the great vessels, are enclosed in a sac, the pericardium. The musculature of the atria is thin and their contractions manifest themselves by rapid peristaltic superficial undulations. The ventricular musculature is rather thick and the contractions are represented by deep pulsations. The communications between the atria and ventricles, the ventricles and the great vessels are guarded by valves which normally allow the blood to travel in only one direction. During contraction of the heart, all its diameters decrease and a definite quantity of blood is ejected into the already filled aorta and pulmonary artery which expand by virtue of their elasticity. During relaxation the diameters of the heart increase, while those of the vessels return to their original state. The difference in the volume of the heart and vessels between the systolic and diastolic phases is manifested by an inward and outward movement of their walls, this event being felt as the pulse, which represents a complete cardiac cycle. The duration of the average cycle is 0.8 second, of which 0.3 second is occupied by the ventricular systole and 0.5 second by the ventricular diastole. Beside the proper physical mechanism of the heart, valves, and vessels, normal cardiac contractions can take place only so long as the functions of stimuli production, excitability, conductivity, and tonicity are unimpaired and co-ordinated by the nervous system.

The most frequent pathologic changes of the heart, valves, and vessels which may modify more or less cardiac and vascular pulsations are the following: cardiac infarctions, cardiac aneurysms, cardiac hypertrophy and dilatation, degenerative changes of the heart muscle, disease of the vessels, diseases of the pericardium, congenital affections, and disturbances in the mechanisms of the beat. Among the most frequent vascular changes are aortitis, syphilitic aortitis, arteriosclerosis, aneurysms, alterations in blood pressure, pulmonary artery affections, and pulmonary disease.

An analysis of a roentgen kymogram reveals the general outline of the heart and great vessels with depressions and elevations of varying dimensions along their margins (Figs. 1, 2, 3, and 4). The extreme end of the depression indicates complete contraction of the heart while the apex of the elevation or wave indicates complete relaxation. Between opposite apices and depressions across the heart shadow, there are bands or zones of lighter and darker shades, respectively, which indicate the variations in the volume of the heart during diastole and systole. Their presence proves that the waves are the result of expansile pulsations, whereas their absence may indicate that the pulsations are only transmitted.

Study of the waves reveals that they all possess certain features in common, among which are their resemblance to the inverted letter "V." With the cassette travelling downward, the lower limb is formed during the diastolic phase, the upper during the systolic one. The apex of the wave repre-

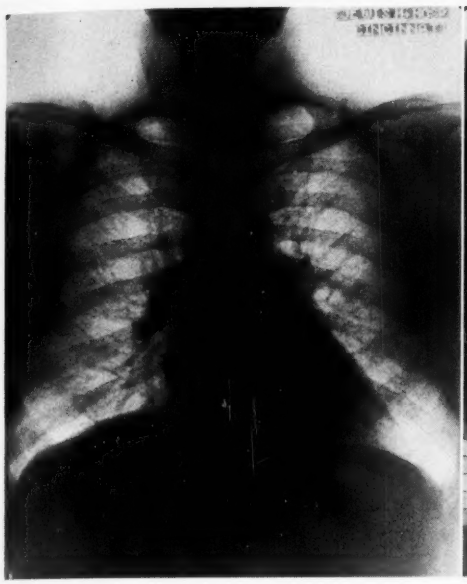

Fig. 5.

Fig. 6.

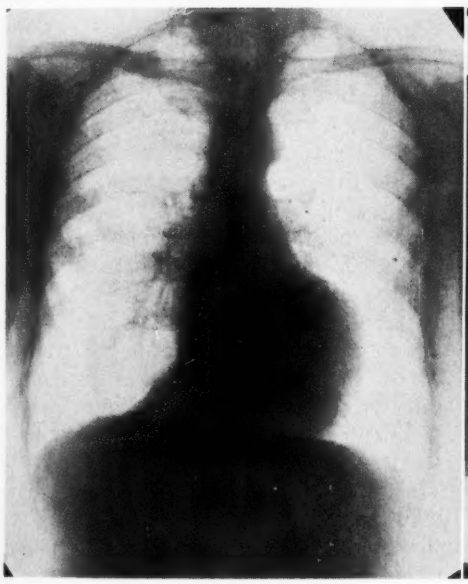

Fig. 7.

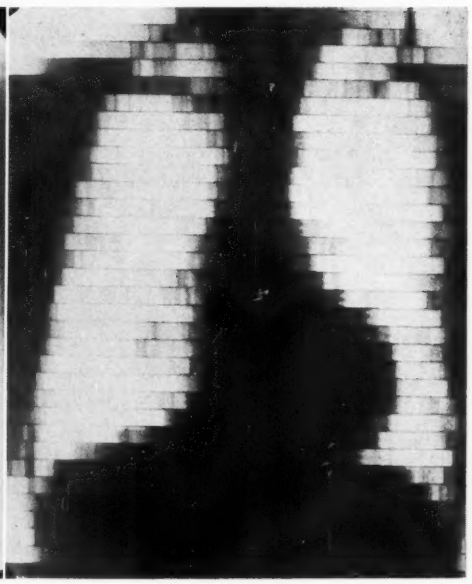

Fig. 8.

sents the completion of diastole, the trough that of systole.

The special characteristics of the waves are studied under the following headings: type, amplitude, length, form, and contour. However, no sharp distinction can be drawn between these characteristics, as they are more or less interdependent.

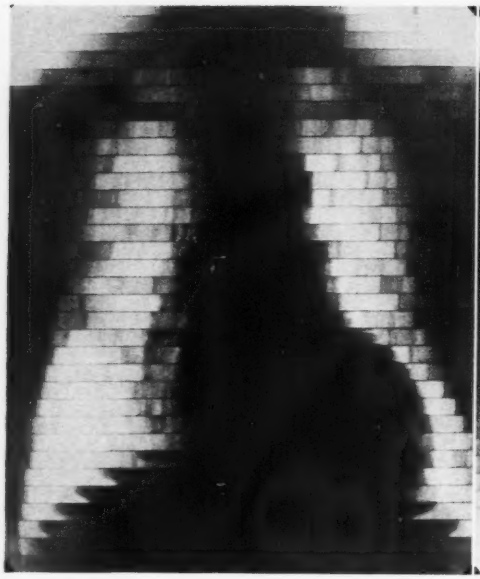

Fig. 9.

Fig. 10.

The type of wave depends upon the structure from which it originates and is sufficiently distinct to enable one to outline the position of the ventricles, atria, and vessels. The amplitude of the wave is of the greatest importance, indicating as it does the condition of the cardiac and vascular musculature, force of heartbeat, difference in the size of the heart between systole and diastole, and, to some extent, pulse pressure. The length of the wave which expresses the duration of the cardiac cycle makes it possible to determine the time relation of the diastolic and systolic phases by dropping a perpendicular line from the apex to the base line. That section of the base line joining the upper limb represents systolic time, the section joining the lower limb, diastolic time. As a rule, one will find the diastolic time greater than the systolic. The form and contour of the wave depends upon the variations in the speed of inflow and outflow of the blood. The ventricular waves resemble the sharp end of a pencil and their amplitude usually exceeds those of the other structures. In general, ventricular waves bear a strong resemblance to ventricular volume curves.

The auricular waves are minute and multiple and do not lend themselves to a careful analysis. They serve, however, to outline the auricular chambers. The waves of the vena cava superior, when recognizable, resemble those of the atria.

The vascular waves of the aorta and pulmonary conus are quite characteristic. In form they strongly resemble inverted steps, consisting of right-angle triangles. The lower limb which represents systole is directed outward in a straight line perpendicular to the vessel wall and is the result of rapid expansion of the vessel. The return of the vessels to their original state during diastole takes place more slowly and is represented by an oblique upper limb. A comparison between the waves exhibited by the large vessels and those of the carotid sphygmograms shows a striking similarity. The above description of the waves as primarily due to the cardiovascular action is true to a large extent, but not entirely so, being more or less modified by other factors, such as the

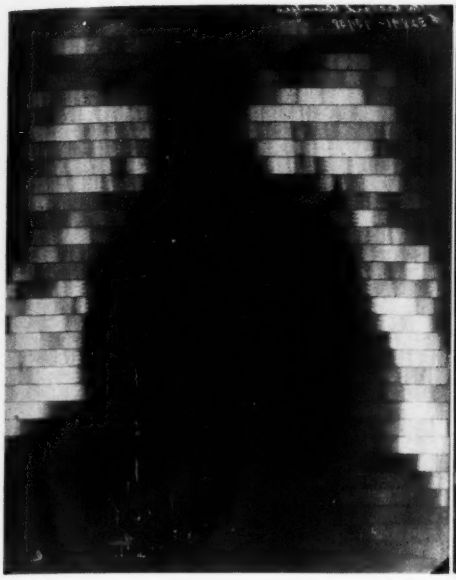

Fig. 11.

Fig. 12.

rotary movement and changes of position of the heart and vessels as a whole which take place during a cardiac cycle.

A study of the waves makes it possible to determine the relative size of the heart during diastole and systole. The determination of the difference in size gives one some idea regarding cardiac output. Johnson (7) and Ungerleider and Gubner (8) have made use of this method in their studies of heart output. An analysis of the waves makes it possible also to determine the time relation of the events which occur simultaneously in the several structures by comparing points equidistant from the white lines.

The above discussion completes the description of the normal physiologic dynamics of the heart and great vessels as revealed by the study of roentgen kymograms of normal individuals. In the following we have chosen a number of pathologic cases illustrating various deviations from the normal.

Coronary Disease.—As a result of coronary artery disease, such as sclerosis or thrombosis, fibrotic changes may occur in the musculature of the ventricle, the most frequent area involved being the lower half of the left ventricle. These organic changes impair the contractility of the musculature, which, when viewed fluoroscopically, reveals diminished or complete absence of pulsations. The heart may show little or no enlargement and the contour of the left ventricular border will have lost some of its convexity (Fig. 5). A roentgen kymogram may show diminished or absent pulsations in one or more frames (Fig. 6). Occasionally, instead of the flattened border there may be a pronounced bulging in the heart contour, the result of a cardiac aneurysm (Fig. 7). Fluoroscopically the pulsations may be entirely absent or present in a paradoxical form, depending upon the stage of the disease. In cases of long standing, with greatly thickened and sclerosed walls, one is not likely to find evidence of pulsations (Fig. 8). As a rule, patients presenting such kymograms give a history of coronary disease.

Cardiac Enlargement.—Enlargement of the heart may involve the entire organ or

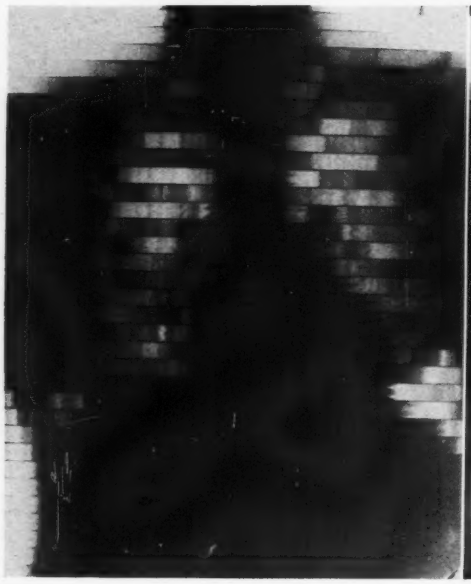

Fig. 13.

Fig. 14.

one or more of its chambers, and may be due to hypertrophy or dilatation or both. The pulsations may be increased in the early stages of hypertrophy and diminished in the latter stages, as a result of fibrosis or degenerative changes of the cardiac musculature which impair its contractile power. Figure 9 shows a good example of marked enlargement of the heart due to dilatation in a case of systemic arterial hypertension. The left border of the heart shows hardly any pulsations or waves. The arterial pulsations show waves of low amplitude with a slowly descending diastolic limb which is typical of a case with hypertension. In pulmonary hypertension, the same condition probably prevails in regard to the pulmonary artery (Fig. 10). The pulmonary conus shows definite dilatation but the amplitude of pulsation is greatly diminished. In dilatation of the heart, the amplitude of the wave is invariably reduced, as is shown in the case of an advanced mitral lesion (Fig. 11). The frequency of pulsations was greatly increased, but three days later after a course of treatment with digitalis there was a reduction in rate and the waves showed a moderate increase in amplitude (Fig. 12).

Chronic Valvular Disease.—In aortic incompetency (Fig. 13) the left ventricle is enlarged and the apex is rounded. The pulsations are, as a rule, increased in amplitude as a result of the greater force necessary to eject the blood. The aorta is not dilated, but its pulsations reveal a decided increase in the amplitude. The collapsing character of the diastolic limb is typical of this condition and indicates the marked difference between systolic and diastolic pressure as shown by an increased pulse pressure. In a more advanced case of aortic incompetency (Fig. 14), the left ventricle shows marked enlargement. The aorta is dilated and elongated. The ventricular pulsations show increase in the amplitude. The aortic pulsations or waves are increased and also present the typical collapsing character of the diastolic limb.

In mitral lesions the amplitude of the left auricle, right ventricle, and pulmonary conus is often increased in the early stages

Fig. 15.

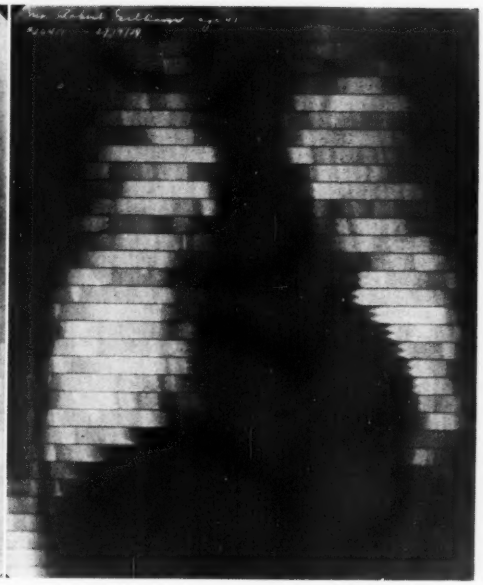

Fig. 16.

of the disease. In advanced cases in which dilatation of the heart has taken place, the waves show a diminution in amplitude (Figs. 11 and 12). A case of typical mitral stenosis (Fig. 15) shows the amplitude within normal limits, but the form is modified, as shown by the obtuse apices of the left ventricle and split waves of the right ventricle. The aortic waves are of small amplitude. In another case suggestive of a tricuspid lesion, there is increased amplitude of the pulmonary waves and the entire right cardiac border (Fig. 16) exhibits ventricular waves of increased amplitude while those of the left ventricle are diminished.

Combined valvular lesions, as mitral and aortic, are frequently encountered. The configuration of the heart is a combination of mitral and aortic lesions. The amplitude of the waves of the several structures will depend upon the predominating lesion. In the case in which mitral regurgitation is predominant, the left ventricular pulsations show an increase in the amplitude (Fig. 17). In this case the aortic waves are also quite prominent, indicating the presence of an aortic regurgitation. When the aortic regurgitation is the predominating factor (Fig. 18), the aortic waves are increased in amplitude and show the characteristic diastolic collapse.

In aortic and pulmonary artery stenosis, the most typical kymographic finding is the form of the wave of the aorta and pulmonary conus. The amplitude of the wave is generally small. The lower limb is oblique which indicates some impediment to the outflow of the blood. A case of aortic stenosis is illustrated in Figure 19. The left ventricle is enlarged, but the aorta is not dilated. The form of its waves is more or less typical of stenosis. The other case (Fig. 20) is that of a congenital heart disease with pulmonary stenosis. The pulmonary conus is dilated with waves showing the characteristic form of stenosis.

In arteriosclerosis the amplitude of the waves depends upon the type and the stage of the disease. It is often increased in such cases because of the movement of the vessel as a whole. The apices of the waves

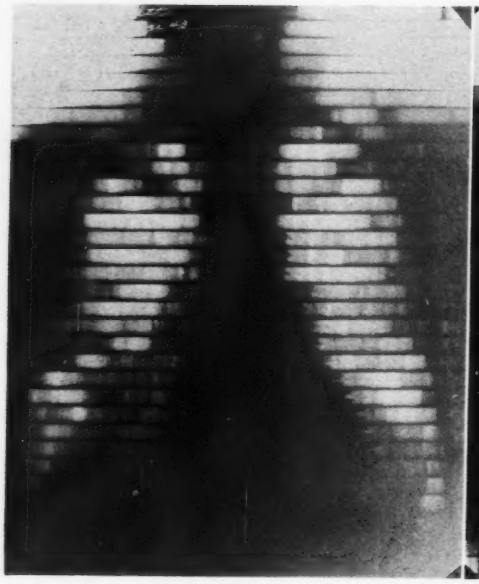

Fig. 17.

Fig. 18.

Fig. 19.

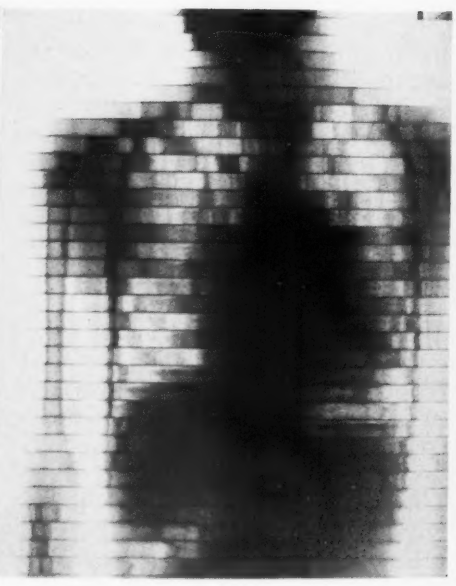

Fig. 20.

are obtuse, showing evidence of loss of elasticity of the vessel wall (Fig. 21). When calcified plaques are deposited in the wall of the vessel (Fig. 22), the amplitude of the waves is definitely diminished. In syphilitic aortitis the waves are

Fig. 21.

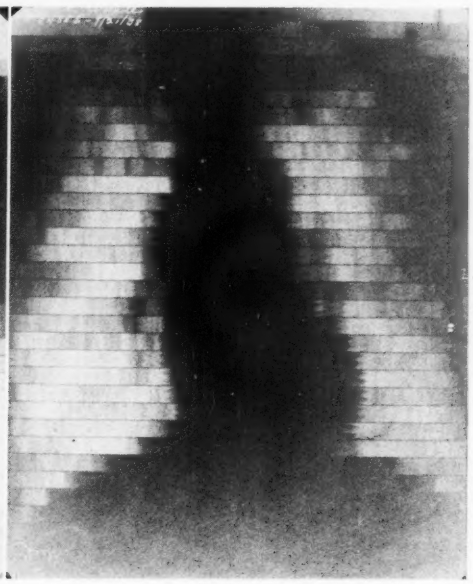

Fig. 22.

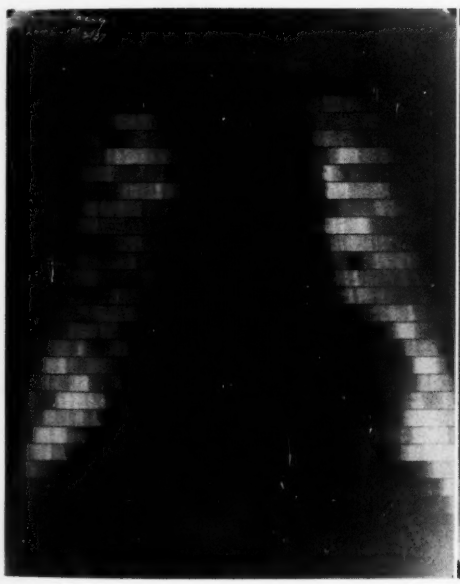

Fig. 23.

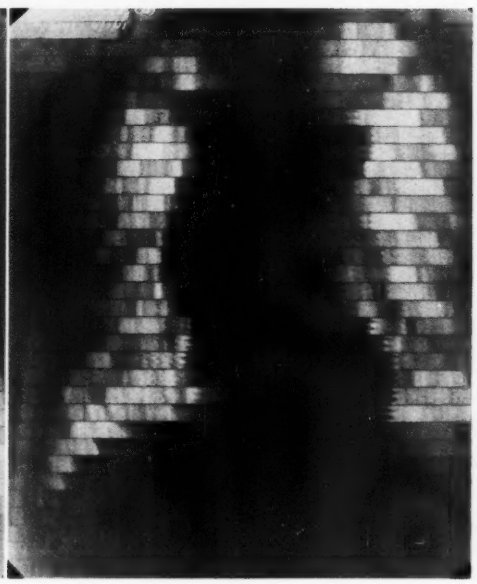

Fig. 24.

frequently increased in length and amplitude (Fig. 23), due to degeneration of the elastic fibers. In advanced syphilitic aortitis with aneurysmal dilatation (Fig. 24), the waves show a very low amplitude.

In saccular aneurysms the presence or

Fig. 25.

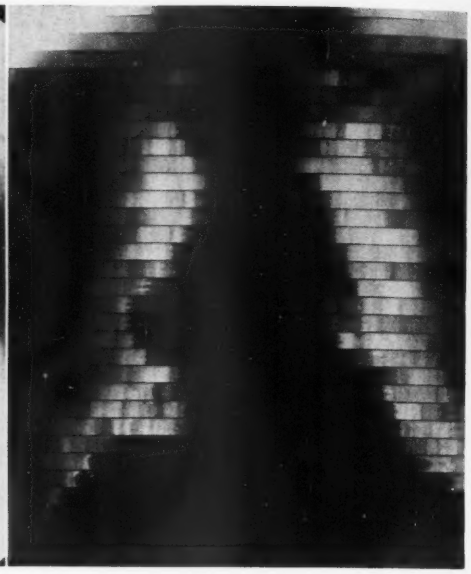

Fig. 26.

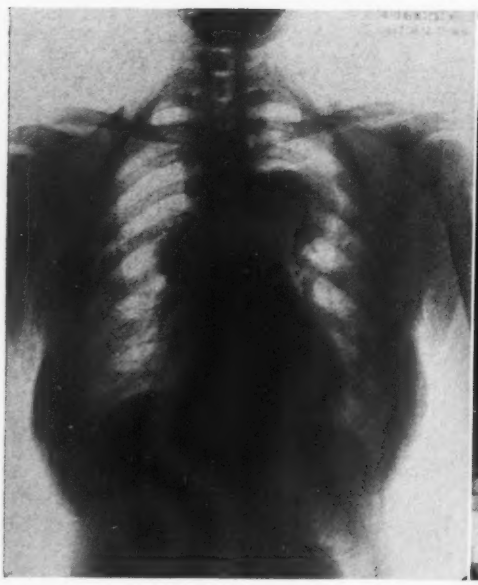

Fig. 27.

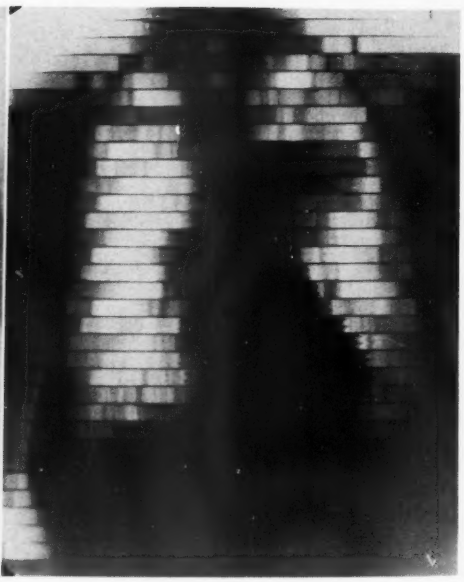

Fig. 28.

absence of pulsations or waves varies with the stage of the disease. In the early stage, when there exists a free communication between the aorta and the aneurysm, there is positive evidence of expansile pulsations as shown by the waves and zones

Fig 29.

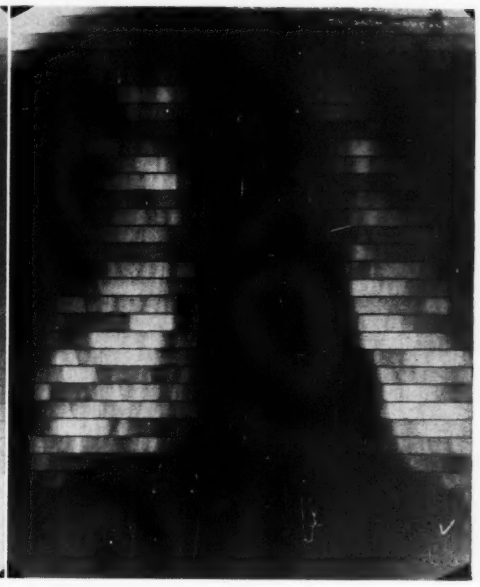

Fig. 30.

of lighter and darker shades. This is illustrated by the following two cases. In the first case (Fig. 25) there is present a large sacculation arising from the lower region of the right vascular border. In the region of the innominate artery there is a definite dilatation of the vessel toward the right side. Fluoroscopically, pulsations were noted in both. The roentgen kymogram (Fig. 26) shows distinct expansile pulsation of the lower prominence. The diagnosis of a double aneurysm was confirmed by autopsy. In the second case (Fig. 27) there are two sacculations, one arising from the right border of the vascular shadow and the other from the aortic arch on the left. Fluoroscopically, both shadows were seen to pulsate. The roentgen kymogram shows definite evidence of expansile pulsation confirming the diagnosis of a double aneurysm (Fig. 28).

In differentiation between mediastinal tumors and aneurysms, great reliance is placed upon the presence or absence of pulsation. Expansile pulsation in a tumor invariably indicates an aneurysm; however, in the case of transmitted pulsations one is less certain of the diagnosis. Our experience has been that mediastinal tumors present neither type of pulsation, while an aneurysm may show either kind, depending upon the stage of the disease. Thus, in the presence of a thick wall and blood clots there may be transmitted only pulsations. In Figure 29 there is shown a large mass in the region of the arch of the aorta, due to an aneurysm. There are noted some pulsations or waves of a rather impaired form which are probably due to transmitted pulsations. On the other hand, in Figure 30 there is seen also a large mass in the anterior mediastinum overlapping the great blood-vessel shadow, no pulsations or waves being present. The fact that the mass retrogressed under x-ray treatment proved its true nature. Figure 31 illustrates another case of a superior mediastinal tumor which is located to the right of the aortic arch. The roentgen kymogram (Fig. 32) shows no evidence of pulsation, notwithstanding its immediate proximity to the aortic arch. This is one of several cases confirming our opinion that no pulsations are observed in tumors, while aneurysms

Fig. 31.

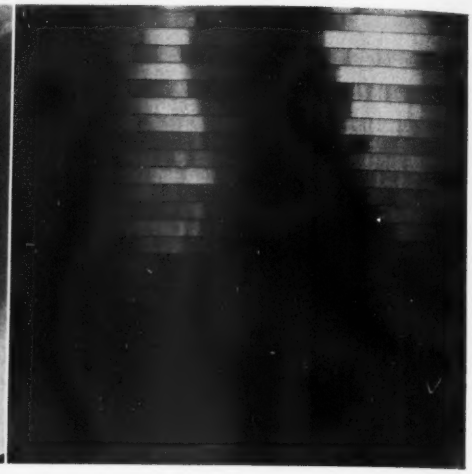

Fig. 32.

may show either expansile or transmitted pulsations.

A rather unusual location for a mediastinal tumor is illustrated by Figure 33. A large tumor is noted lying along the right border of the cardiovascular shadow. In the lateral position the mass was seen to overlap the heart, yet in spite of its proximity no pulsations were recognizable (Fig. 34). Another interesting case is illustrated by Figure 35 which shows a small circumscribed mass on the right side of the cardiac border just above the diaphragm. Definite pulsations were noted fluoroscopically. The roentgen kymogram (Fig. 36) shows minute auricular pulsations with zones of darker and lighter shades which indicate expansile pulsations. Because of this finding, the mass was believed to be a cardiac aneurysm. Inasmuch as this patient had had a previous amputation for sarcoma of the leg, it was thought advisable to institute radiation therapy. No retrogression has taken place.

Discussion.—Having examined over five hundred individuals with roentgen kymography in the past two years in an attempt to evaluate the merit of this method in the diagnosis of cardiovascular disease, we are of the opinion that a careful fluoroscopic and ordinary roentgenographic study of the chest will enable one to make a fairly good estimate of the condition of the heart and vessels. In a vast majority of cases the new method had only a confirmatory value. However, as a permanent record of the fluoroscopic observations, roentgen kymography has no equal, giving a more thorough insight into the nature of cardiac action and providing an opportunity for a more diligent study of cardiovascular dynamics.

Conclusion.—The historical development of roentgen kymography is briefly reviewed. The principle and technic are described. The physiologic processes related to movement of the cardiovascular dynamics under normal and abnormal conditions are discussed in more or less detail. It is concluded that roentgen kymography provides a permanent record of roentgenoscopic observation. It is rarely of direct aid in diagnosis but helps to confirm the roentgenoscopic and roentgenographic findings.

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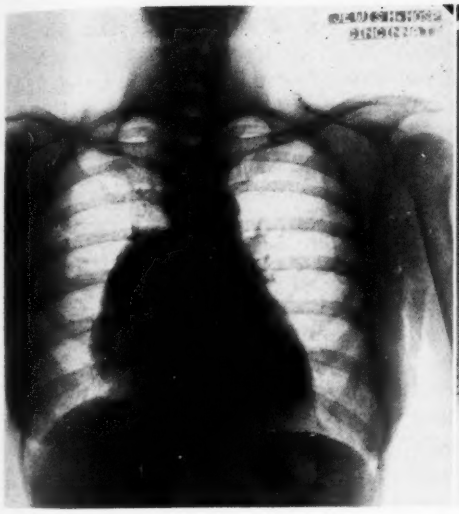

Fig. 33.

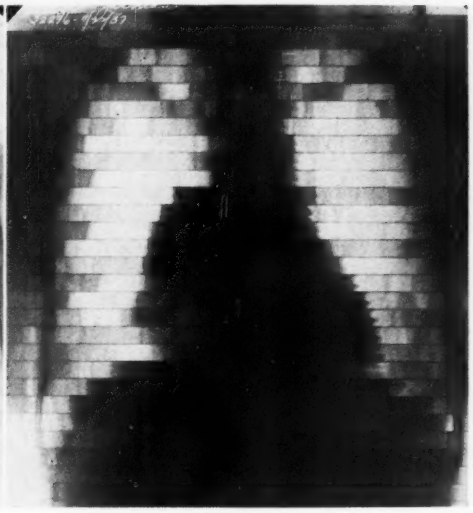

Fig. 34.

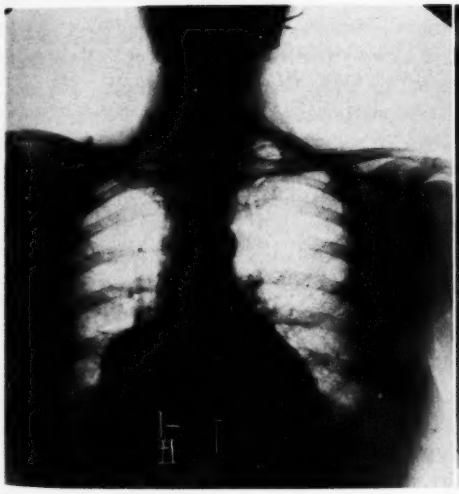

Fig. 35.

Fig. 36.

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DISCUSSION

WENDELL G. SCOTT, M.D. (St. Louis): Dr. Brown has given a summary of many of the cardiac diseases and disorders in

which the kymograph is helpful. I think we should be conservative in our estimates of the value of kymography. It is only by presenting a series of cases like this and following them to autopsy that we can determine the position that is to be accorded kymography in the diagnosis of heart disease.

There are three things which we should remember about kymography. First, that the kymograph is designed to supplement roentgenographic and fluoroscopic studies of the heart—it is not designed to replace either one.

Second, kymography is only one procedure in the diagnosis of a patient with heart disease. The history, clinical findings, and laboratory reports all have to be balanced by the clinician together with the roentgen kymographic reports.

And third, the roentgen kymograph will stimulate any of those who use it to get out their physiology books on the heart and to read new books on heart disease so that, when patients come to them, they will be more familiar with heart disease in general. They can ask these patients intelligent questions and make an adequate roentgen study of them just as we do when we make gastro-intestinal examinations. We should have the same type of knowledge about heart diseases as we have about gastro-intestinal diseases.

I enjoyed this presentation and I assure you that Dr. Brown has been thorough in his study of heart disease with the kymograph. As he mentioned, my ideas are not the same as his concerning the kymographic diagnosis of aneurysms.

MERRILL C. SOSMAN, M.D. (Boston): Unfortunately in meetings of this kind papers are usually discussed only by those who are in agreement with the authors or speakers. It is getting all too rare and infrequent to have anybody put up what you might call the negative or opposite side, and I take the liberty of becoming personally unpopular with Dr. Brown and Dr. Scott by telling you of my experiences.

We have used the kymograph for two and a half or three years at the present time. It is a very interesting plaything. As an aid in the diagnosis of heart disease, we have considered it to be worthless. The only condition in which we use it at present is in adhesive pericarditis in which we wish to record the amount of excursion of the cardiac outline before and after operation.

As to diagnosing coronary disease and infarcts of the ventricle, I am perfectly sure that you would be misled more often than you would be correct if you used the kymogram in the way in which it has been described, because in a great many cases in which you have a beat which is perpendicular and not horizontal, it will give you a perfectly flat left border in one, two, or three frames. In fact, several of the cases which Dr. Brown showed toward the end of his demonstration showed no pulsation on the left border of the heart, and if he were to be consistent, he would have to say that this patient also has coronary disease and presumably an infarct of the myocardium at that point.

Still further, the aneurysms of the aorta more frequently show a diminished pulsation than an increased pulsation in the area of the aneurysm, as any of you can see if you just ask yourself the question, as you fluoroscope the patient, "How much does this particular area pulsate?"

Finally, you can get increased ventricular pulsations exactly the same as those in aortic insufficiency in cases of anemia, hyperthyroidism, and unilateral pneumothorax. In fact, the most striking pulsations of that type are seen in patients with unilateral pneumothorax, and that very unusual pulsation on one side may lead you to the diagnosis of that condition when the pneumothorax itself is so small as to be not visible.

Careful fluoroscopic study of the heart will give much more information than the kymogram, which records only a small part of what you can see if you look for it.

FRANK LIBERSON, M.D. (New York City): I have used the kymograph for

the past six years. In part, I made my own and used it for about three and a half years. I found great difficulty with it, largely because of mechanical reasons. For the past two and a half years, I have used a commercially manufactured kymograph, and have found, in truth, that the difficulty is not with the kymograph but with me, for I do not understand enough of what it shows. I feel confident that when we understand it better we will be less prone to condemn it.

LEO G. RIGLER, M.D. (Minneapolis, Minn.): I have not had enough experience with kymograms really to dispute what Dr. Sosman has said, although I am much inclined to do so.

I would like to call attention first to two points: He mentioned the matter of constrictive pericarditis and we, too, have found it of great value, largely in demonstrating graphically the change in the degree of pulsation, for example, before and after operation. Furthermore, we have had an experience in one case, particularly, in which from fluoroscopic and other studies there was grave doubt as to the presence of a constrictive pericarditis, so much so that this child was not properly treated for a long period of time.

The reason for the doubt was that we were able to observe what appeared to be normal pulsations of the heart throughout its extent. On kymographic study, however, we were able to demonstrate a local area, repeatedly and constantly, of such greatly diminished pulsation that we finally arrived at a diagnosis of constrictive pericarditis. This area had been observed fluoroscopically, but was so local that we were reluctant to depend upon it. At operation the constriction was found to be only partial in the heart and the findings observed were, therefore, substantiated.

I mention this only because it did give us a good deal more fortitude in having this child operated upon when, otherwise, we might have delayed further, the clinical findings not being as characteristic as they might have been.

There is one other point worth observing which bears out the fact that one must have a thorough understanding of the physiology of this mechanism to appreciate what has taken place. Dr. Brown mentioned several times, I think, the difference in the degree of expansion of the heart or, let us say, of the amplitude of the pulsations, as between aortic insufficiency and, let us say, hypertensive heart disease. It is a striking example which illustrates a point that is of some interest.

In the instance of a large heart which does not have an insufficiency of the valve, it is inevitable that the difference between the systolic and diastolic volume of the heart as measured in this way must be small because the output of that heart for each stroke will be approximately the same as that of the normal heart. If you have a much larger area to measure and, therefore, a much larger volume, the difference between systole and diastole should be quite small; therefore, the amplitude of the wave will be small.

In the case of aortic insufficiency, the output of the heart per stroke must be increased enormously because of the regurgitation, because that heart is inefficient. As a result, of course, the amplitude of the wave is not only normal, which means that the output is much greater than that of a normal heart would be, because of the greater size of this heart, but it is perhaps in many cases even greater than normal.

If we think of these physiologic explanations, the value of the kymogram is, of course, greatly increased.

One more point I think should be brought out—I am sure Dr. Brown meant to do so. That is that tumors in the mediastinum give pulsations in the kymogram. Sometimes it is possible to distinguish between the pulsations of the tumors and those of the aorta, but I am not always certain about it.

Likewise, we know—as Dr. Sosman has pointed out—aneurysms may show so little pulsation that it is difficult to distinguish them from tumors, so that in our

experience, too, the kymogram does not offer us a great deal more than our other observations in making the distinction.

SAMUEL BROWN, M.D. (*closing*): I wish to express my thanks to everyone who has discussed the paper, and especially to Dr. Scott who has been responsible, to a great extent, for my enthusiasm in roentgen kymography.

I believe that by studying the publications of Dr. Hirsch and Dr. Scott all of us will become interested in the subject.

I am not going to quarrel with my friend, Dr. Sosman. He may change his mind.

Regarding the inconsistency of my interpretation, to which he calls attention, I can only state that there are a number of conditions which show diminished pulsations and the differentiation will depend upon other factors which are fully discussed in the paper.

In regard to Dr. Rigler's remarks, I may say that, according to several case reports, it is quite true that some aneurysms do not pulsate, while mediastinal tumors may, at times, pulsate. However, in my experience during the past two years, I have found that aneurysms invariably pulsate although their pulsations may be greatly impaired, while mediastinal tumors never pulsate. I may also add that at present, as in the past, I have succeeded in differentiating aneurysms from mediastinal tumors without roentgen kymography.

A REPORT OF A FEW RECENT EXPERIMENTS ON THE BIOLOGIC EFFECTS OF MAGNETIC FIELDS[1]

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TRANSLATED AND REVISED FOR PUBLICATION UNDER THE SUPERVISION OF G. FAILLA, NEW YORK CITY

I WISH to make a report, necessarily brief and summary, of experiments and observations, begun five years ago, and, up to the present, pursued uninterruptedly. In the course of these, my collaborators, Dr. Balli, Dr. Livi, Dr. Muzzioli, and I have obtained results which we believe not lacking in interest, and have met with no small difficulties which we believe to have overcome within all possible limits.

Thanks to the co-operation and interest of our instructor, Prof. Balli, thanks to the advice and opinion of physicists and pathologists of our University and of technicians of the Scuola Industriale of Modena, it has been possible for us to obtain the results which we here present, reserving a more exhaustive treatment of the biologic effects of magnetic fields to a work of greater extent which will be published in the near future, in *Strahlentherapie*.

On the occasion of the first, second, and third meetings of the Congresso Italiano di Radiobiologia[2] and other scientific conventions, in articles previously published (1), and in our Treatise on Radiobiology (2), some of the results of our experiments have already been communicated. In this report it is my intention, rather than to draw conclusions, to throw light on the present situation and to gather from this the directives for the further advancement of our research on this subject.

The studies on the biologic effects of magnetic fields are, in reality, very few; their conclusions are extremely contradictory; the interpretation of the action of these physical agents is as yet obscure: for all these reasons we have thought this subject worthy of research, even though, at least for the present, this research may not settle all those contradictions or make clear all this obscurity.

The first part of the present report will include a brief and summary description of the apparatus used, and of the principal methods of experimentation. The second part will contain a brief discussion of some experiments by other workers, together with a report of our own results. In the third and last part will be set forth certain considerations of a general character.

PART ONE

The greater part of our experiments were performed with large electromagnets with laminated cores, capable of functioning either with direct or pulsating current at 3.3–10–16 cy./sec., obtained by means of rotary mercury switches, or with alternating current at 42 cy./sec., or at 466–653–933 cy./sec., obtained with motor-alternator groups. Such electromagnets, with 120 v., 1.5–2 amp. direct current, generate fields of from 1,500 to 1,700 gauss. Adequate methods of cooling keep the temperature between the poles constant.[3]

The animal used in our experiments was for the most part the white mouse, due to

[1] From the report presented before the Fifth Italian Congress of Radiobiology, Turin, May, 1939, XVII.

[2] See respective reports.

[3] At present we have plans for a new electromagnet which, according to calculations, could furnish a direct or alternating field of about 15,000 gauss. With this magnet which, due to certain new structural characteristics, could function for as long as a month without interruptions with constant and uniform temperature between the poles, and between the poles of which could be placed even animals of considerable size, we plan to proceed with our research on the biologic effects of magnetic fields.

the convenience of its small size. The individual animals were set between the poles of the magnet, enclosed in special cellophane cells, which were always perfectly insulated. Macroscopic examinations were always complemented with microscopic, and the results obtained were expressed graphically wherever possible. Some of the research that I shall report on has not as yet been completed with respect to the histological data.

PART TWO

My collaborators and I have experimented on the following "objects": solutions (study of the surface tension and electric conductivity); colloidal suspensions (study of the surface tension, electric conductivity, and Brownian movement); bacteria (reproductive power and chromogenic activity of *Bacillus pyocyaneus*); saccharomyces (study of the fermentative power of *Saccharomyces cerevisiæ*). The truly interesting results obtained by Madame Lengyel in 1933–1934, by Huzella in 1934, by De Lorenzi in 1935 and 1939, in their experiments on the effects of direct and alternating magnetic fields on cells cultivated *in vitro*, induced me, partly with those collaborators whom I have already mentioned, to prepare and execute researches in which, excepting in one subject, I am not aware of having been preceded by anyone, that is, on the possibility of producing analogous effect on embryos and the tissues of adult animals in normal conditions; on the possibility of influencing the reparative process of skin and bone wounds; on the behavior of embryonic material introduced in experimental animals, and lastly, on the growth and development of experimental tumors, such as the Ehrlich adenocarcinoma.

Beside these experiments, still others were made on the course of the autolytic phenomena in fragments of normal and pathologic tissues, on human blood (study of the surface tension of serum, of electric conductivity, of the rate of sedimentation of erythrocytes, of the permeability of these, etc.), and on the cardiac function.

It is with deep regret that in order to remain within the time allowed to a summary report I am obliged to forego an illustration of the results obtained in the experiments which I have enumerated. Let me, however, give you a brief description at least of three groups of experiments: that is, of those concerning the action of cells cultivated *in vitro*, of those performed on the processes of reparation of cutaneous and bone wounds, and lastly, of those which I personally completed on the Ehrlich adenocarcinoma.

EXPERIMENTS ON CELLS CULTIVATED *in vitro*

This is, I think, a field of the greatest interest, in which the results are such as to deserve particular attention, notwithstanding the fact that the cell cultivated *in vitro* is in many characteristics and conditions unlike the living one which forms part of a tissue or an organism. I am obliged to describe only the experiments of others, as I am not yet prepared to present my personal results. Hermann (3) first, and then Errera, in 1890 (4), had expressed the opinion that the mitosis is insensible to the effect of magnetic fields, an idea which was taken up again in 1936 by Payne-Scott and Love (5) who, on the basis of their own results with cells cultivated *in vitro*, ascertained, on the other hand, a certain sensitivity to the same fields on the part of protoplasm of resting cells. Again, Madame Lengyel (6), in 1933–1934, reports the observation of the evident effects of a direct magnetic field on the growth and organization of cultures of heart cells of chicken, which may be attributed on the one hand to the breaking down of the fibrillary system and to the disturbance of what Driesch synthetically called the "unitary harmonic factor," and on the other hand to the atypic cellular morphology (abundant formation of giant cells, even of considerable and unusual size). In 1934, Huzella (7), by means of alternating magnetic fields, obtained a singular configuration of the cultures, the polar development of which is attended by variations in the shape and orientation of

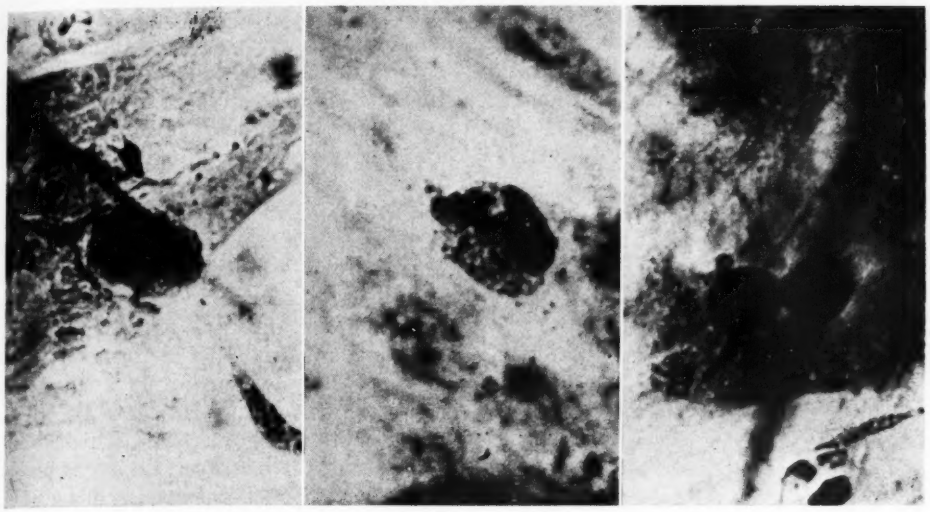


Fig. 1. Fig. 2. Fig. 3.

Fig. 1. First stage of chromosome agglutination (×980), after De Lorenzi.
Fig. 2. Agglutination of chromosomes and degenerative phenomena of the cell body (×1520), after De Lorenzi.
Fig. 3. Irregular division of maternal chromatin in two daughter cells (×1660), after De Lorenzi.

the cells. The same study of continuous magnetic fields on cultures of heart, great vessels, and spinal ganglia was taken up by De Lorenzi (8) in 1935 and continued in 1939. He does not note particular orientation of cells or fibers, but he finds a marked diminution of the mitotic coefficient. He reports, too, that with applications of short duration and little intensity, an inhibition to the formation of the equatorial constriction is observed, so that the duration of the anaphase is greatly prolonged; this causes an apparent increase of the "mitotic coefficient" in such experimental conditions (Figs. 1–4).

It is interesting to compare the agglutinations, the chromosome fragmentation, the irregularities in their migration, the asymmetric pseudo-mitosis, the tripolar or multipolar mitotic divisions, the formation of giant cells—in other words to compare all the results described and copiously illustrated by Mme. Lengyel and De Lorenzi with those described by many others who have experimented on the action of x-rays and other physical agents on cells cultivated *in vitro*. One may find in them

Fig. 4. Polynucleated giant cell (×1170), after De Lorenzi.

singular points of similarity which ought to be put side by side with those similarities that Saito (9), in 1936, showed to exist between the functional alterations caused by magnetic fields in rabbits and rats, and the so-called "*Röntgenkater*."

In conclusion, it may be remarked that whereas the direct magnetic field seems to

act on the course and the appearance of the mitosis, the alternating field seems rather to have effect on the order and orientation of the entire culture and of the elements of which it is composed.

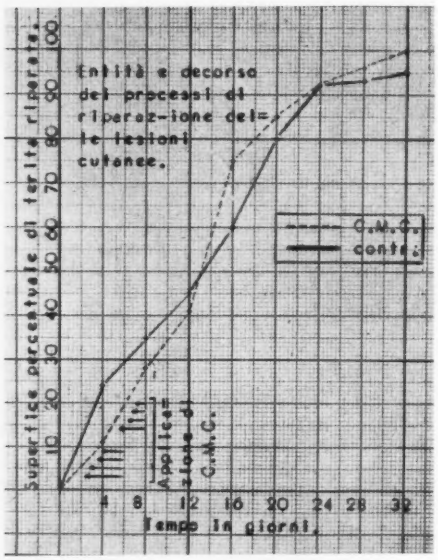


Fig. 5. Extent and behavior of healing of cutaneous wounds. Continuous magnetic field. *Horizontal:* Time in days. *Vertical:* Surface of healed wound in percentage. C.M.C. = constant magnetic field. Contr. = controls.

EXPERIMENTS ON THE PROCESS OF REPARATION OF SKIN AND BONE WOUNDS

These researches of ours, which are, as far as I am aware, the first of their kind to be performed, for technical reasons were executed only with electromagnets fed by direct current, and only one pole of these electromagnets was used, the core being arranged in such a way as to obtain in the region of the wound the maximum concentration of lines of force.

With my collaborator, Dr. Muzzioli, I have already given, in 1938, a report of the results obtained from these studies, with regard to the macroscopic aspect. With the data obtained by measuring the surface of cutaneous wounds, performed with the Carrell-Hartmann planimetric method, and by calculating the equivalent of the surface with Simpson's graphic and mathematical method, we have been able to make some graphs, and among them a curve of reparation or healing (see Fig. 5), from which it is possible to trace the behavior of the object under observation in direct magnetic fields. We also attempted an interpretation of the initial slowing down and of the following increase in the rate of the healing process of cutaneous wounds, both considering the former as a direct consequence of the magnetic field and the latter as a compensatory phenomenon altogether independent of the physical stimulus previously applied, and considering the increase in rate as a direct effect of the magnetic field which would manifest itself after a certain latent period. But how can the initial slowing down be explained in this latter hypothesis?

The histologic research on this subject, in which I was aided by Dr. Livi, is not yet completed as regards a study of nuclear and mitotic changes. Up to the present time, neither microscopic nor macroscopic studies of the course of reparation of bone wounds have shown appreciable and constant differences between subjects placed in direct magnetic fields and those left to heal in the usual manner. However, it must be noted that the exposures to the magnetic field in these experiments were brief; it is quite possible that longer exposures in more intense fields might give different results.

Our research on the processes of reparation was performed on a rather large number of subjects, as we are aware of the importance of such a condition on a statistical study, especially on so delicate and uncertain a subject as the one under present consideration.

EXPERIMENTS ON THE EHRLICH ADENOCARCINOMA

I used in these experiments a stock tumor courteously presented by H. E. Rondoni to our Institute. This stock possesses a high "taking" power (varying from 75 to 95 per cent). On the eighth day the growth is perceptible, and the "taking" is complete in all subjects from the tenth to the eleventh day.

The neoplasms obtained are of considerable size and may weigh as much as from 12 to 14 grams. The death of the animal usually occurs between the thirtieth and fortieth day from the time of the graft.

possible objections that might have been made to these studies in this regard, on the one hand, by determining, through successive graftings on about a hundred animals, the normal rate of "takes" and other

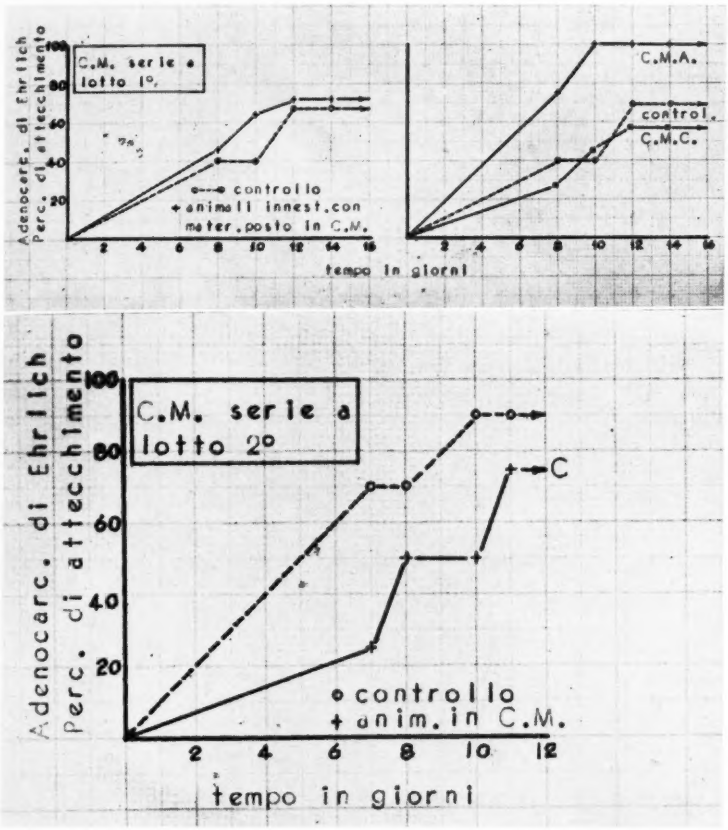


Fig. 6 (*above*). "Takes" of Ehrlich adenocarcinoma. Tumor fragment placed in magnetic field prior to grafting. *Vertical:* Recent "takes." *Horizontal:* Time in days. Left figure: *Broken line* = controls. *Full line* = animals grafted with tumor fragments that have been kept in constant magnetic field. Right figure: C.M.A. = alternating magnetic field. C.M.C. = constant magnetic field. *Broken line* = controls.

Fig. 7 (*below*). "Takes" of Ehrlich adenocarcinoma. Animals placed in constant magnetic field soon after graft. *Vertical:* Percentage of "takes." *Horizontal:* Time in days. + = controls. o = animals in constant magnetic field.

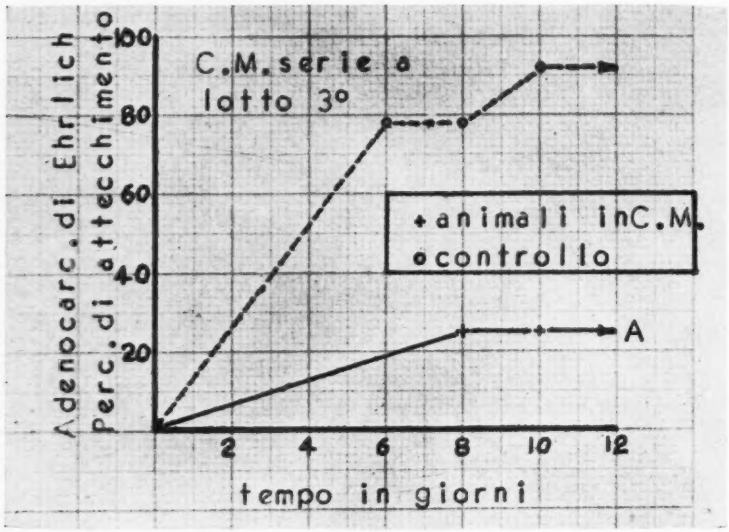
It is well known that many variations are possible in the "taking" power and development of the Ehrlich adenocarcinoma aside from experimental treatment, and depending only on individual and surrounding factors. I tried to prevent the

characteristics of the stock before beginning the experiment; and on the other hand, by performing the experiments on the possible effects of magnetic fields on a great number of animals (286 white mice) so as to be able, by means of a statistical

study on abundant material, to avoid the errors due to individual reactions of an abnormal and exceptional character.

The manners of experimentation which we followed can be divided into three main groups:

I.—*Grafts upon Healthy Animals of Neoplastic Material Previously Kept in Mag-*



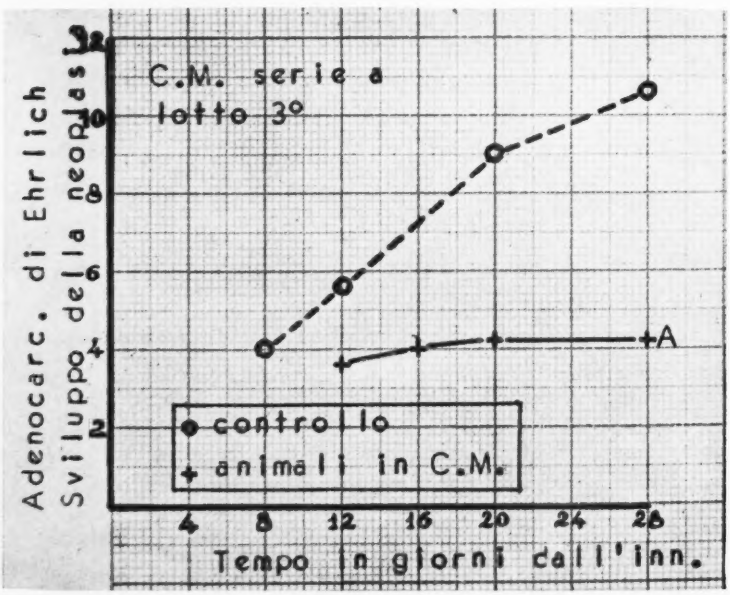


Fig. 8 (*above*). "Takes" of Ehrlich adenocarcinoma. Animals placed in alternating magnetic field (42 cycles per second). o = controls. + = animals in magnetic field. *Vertical:* Percentage of "takes." *Horizontal:* Time in days.

Fig. 9 (*below*). Development of grafted tumors after interruption of treatment with magnetic fields. *Vertical:* Development of Ehrlich adenocarcinoma. *Horizontal:* Time in days from graft.

netic Fields.—In this case I have been able to demonstrate that in general the "takes" occur equally and in the same degree, both with the previously exposed and normal neoplastic material. To be more exact, I will say that between the eighth and twelfth day a greater per cent of "takes" are noticed in animals grafted with material previously treated with magnetic fields. By analyzing these differences, one may notice that they are mostly due to the rapid and total "taking" of neoplastic material placed before grafting in a magnetic field alternated at 42 cy./sec. (see Fig. 6).

II.—*The Effects of Magnetic Fields on "Takes" and Development of Neoplasm Soon after the Graft.*—Here it is necessary to distinguish between the effects obtained experimenting with direct magnetic fields and those obtained experimenting with alternating magnetic fields.

(*a*) In animals placed eight hours per day in a constant magnetic field immediately after the graft, a very marked delay in the "taking" is noticed, and a considerably smaller percentage of "taken" neoplasms (see Fig. 7). By interrupting the action of the magnetic field on the twelfth day, *i.e.*, after a total of 96 hours of treatment, the neoplasms that had already "taken" continued to develop in a way not unlike the normal.

(*b*) In the animals placed in an alternating magnetic field at 42 cy./sec. for eight hours a day, the "taking" was delayed in the highest degree, so that on the twelfth day, while the controls showed 92 out of 100 positive results, these showed only 25 out of 100 (see Fig. 8). By interrupting the action of the magnetic field on the twelfth day, *i.e.*, after a total of 96 hours of treatment, I did not observe any further development of those few neoplasms that had "taken" (see Fig. 9). Upon performing an autopsy 20 days later, these were found to consist largely of well defined fibrous cords or masses, which showed no signs of softening or of metastasis.

III.—*The Effects of Magnetic Fields on the Further Development of Neoplasms Already "Taken."*—In this case, again, we must distinguish between two fundamental ways of experimentation:

(*a*) Animals, bearing quite well developed neoplasms (approximately the size of a large hazelnut), placed on the twelfth day after the graft in a constant magnetic field for eight hours per day for 15 days, failed to show in a uniform way the effect of the magnetic field. Some differences noted could very well be ascribed to individual variations which arise in the course of development of experimental blastoma.

(*b*) The alternating magnetic field at 42 cy./sec., applied eight hours a day for 15 days on animals bearing well developed neoplasm (approximately the size of a large hazelnut), starting on the twelfth day after the graft, did not appear to me to modify in any appreciable degree the further development of the blastoma, in comparison with the control.

The results I have given were obtained from macroscopic observation at autopsy. All the viscera and neoplastic fragments of the tested animals have been preserved for future study, in an effort to explain the observations made up to the present time.

PART THREE

I have already said that I do not wish to consider this report as reaching a conclusion, still less an interpretation, but rather a general exposition of a subject which

Fig. 10.

seems to me worthy of further study and deeper and more adequate research. A suitable interpretation may be possible when further data and, above all, a more unanimous agreement of results will have been obtained from our experiments.

All of those who have concerned themselves with this subject have attempted to give an interpretation, more or less ingenious, more or less satisfactory, of the biologic effects observed in experiments with magnetic fields.

It seems to me, however, that a distinction may already be established in the biologic effects of magnetic fields, between those obtained with constant magnetic fields and those obtained with alternating or pulsating magnetic fields. In this last experimental condition, in fact, I believe that the biologic effect which is obtained may be mostly ascribed to the presence and action of induced currents, which, in the case of experiments with direct magnetic fields, are generated only upon the closing and opening of the circuit.

One more thing I wish to emphasize before I bring my discourse to an end: That for these experiments electromagnets capable of producing fields of extremely high intensity and of functioning many days uninterruptedly with constant temperature between the poles are necessary; perhaps with such means we shall be able to produce in living tissues within an animal organism such reactions as experiments performed on cells in culture have shown to be possible.

Along this line we shall continue our research, sustained by the counsel of our teachers and by the interest and help which the National Research Council has accorded us.

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ROENTGENOLOGIC ASPECTS OF METASTASES[1]

By MAXIMILIAN J. HUBENY, M.D., F.A.C.R., F.A.C.P., *and* MAX MASS, M.D.,[2] *Chicago*

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THE roentgenologist has long sought a basis for rationalizing metastatic processes, particularly as applied to the skeletal and intrathoracic structures. Somehow, these efforts have been disappointing. Large series have been reviewed, and, together with innumerable case reports, constitute a formidable array of evidence from which some conclusion might be drawn regarding the incidence and behavior of metastases. Unfortunately, much of this evidence is lacking in thoroughness. Even in leading institutions it is exceptional to find a 50 per cent roentgenographic work-up; and pathologic confirmation is much less. Careful autopsy examination alone cannot give us an accurate estimate of the incidence of skeletal metastases, nor can the roentgenographic findings without pathologic confirmation serve as an entirely dependable criterion. Certainly, in many instances, the primary site remains a mystery to the roentgenologist. Such a correlation is singularly lacking in the recent literature.

The roentgenologist in his analysis of a case is prejudiced by certain ideas, *i.e.*, that skeletal metastasis from the gastro-intestinal tract is a negligible factor, that squamous-cell carcinomas of the dermis and of the uterus are similarly of no consequence. Many other sources of bone metastasis, such as lymphosarcoma, melanoblastoma, carcinoma of the urinary bladder, testes, and pancreas are considered rarities. The fact that osteogenic sarcoma may occasionally become manifest in distant bones, whether by primary or secondary intention, seems to have escaped attention. Furthermore, convenient rules are occasionally adopted such as, "In carcinoma of the prostate, pulmonary involvement is probably never present in the absence of skeletal metastases." Consequently, only a film of the pelvis and spine is necessary. Or that, in the absence of regional lymph node involvement (*i.e.*, carcinoma of breast), skeletal or pulmonary metastases are unworthy of serious consideration. Or that, skeletal metastases are late manifestations of malignant disease, etc.

The pathologist has long been disillusioned as to the predictability of behavior of metastatic processes. Consider that cancerous neoplasms may be disseminated by the venous, arterial, or lymphatic systems; by direct extension; by drop metastases; by retrograde permeation; by arteriovenous communication; can pass from the lesser to the greater circulation through the pulmonary capillaries, and from the lymphatic to the venous circulation; that great differences in different tumors and in the same tumor all present their own peculiar characteristics; and, finally, that most of the tumor emboli are autolyzed and never take root. This gives the problem a complexion of such overwhelming intricacy as to make impossible even limited generalities. Yet, the roentgenologist remains credulous. Theories often serve to confuse and controvert practical evidence. Whether the mode of spread is lymphatic or hematogenous does not concern our problem, but when opinions are derived indicating the predictability of behavior of cancers, we re-emphasize that neither the general literature nor our own experiences support such contentions. Of course, it is a well established fact that metastases to the pelvic bones and lumbar spine are more frequent than elsewhere. However, in only 10 out of 96 of our cases of carcinoma of the breast and prostate having positive roentgenographic evidence of metastatic cancer were

[1] Presented before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11–15, 1939.

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the pelvic bones and lumbar spine alone involved, and in only 32 cases were these structures involved at all. Is the roentgenologist, then, justified in arriving at any reasonable conclusion if such an examination is negative? Even if we were to include in the examination the thoracic spine, skull, ribs, and sternum, only 45 (less than 50 per cent) of the roentgenographically visible lesions could be detected in our material.

Various contributors dealing with metastatic processes have made casual mention of a higher incidence of skeletal and pulmonary manifestations since the advent of more thorough roentgenographic studies. This is strikingly manifest in our survey. Yet it is fair to say that the higher reported incidences of metastasis to bone falls far short of actuality. On the other hand, the roentgenologist recognizes only about 50 per cent of the intrathoracic metastases especially in cases in which the pleuræ and mediastinal structures are involved. Farrell (1) in a report of 78 cases of pulmonary metastases stresses that roentgenographic findings of congestion or inflammatory change, pneumoconiosis, tuberculosis, pulmonary collapse, pleural effusion, atelectasis, widening of mediastinal shadows, and even accentuated hilar markings may be disguised or unrecognized metastases.

The material herewith presented is derived from the records of the Cook County Hospital Departments of Pathology and Roentgenology, covering 1,365 cases (1929 to 1938, inclusive) seen at necropsy. Practically all of the necropsies were performed by the late Dr. R. H. Jaffé and his associates, Dr. J. D. Kirschbaum and Dr. B. Neiman. There were positive roentgenographic findings in approximately 74 per cent of the cases showing skeletal or pulmonary metastases. Despite the fact that roentgenologic and pathologic findings fall far short of the actual incidence of skeletal metastases, a study of our autopsy material of the past ten years shows a considerable increase over previous estimates. A detailed analysis of our cases of carcinoma of the breast and prostate is also made to emphasize the contention of this paper that there are no dependable criteria for rationalizing metastatic phenomena.

Skeletal Metastases.—In 1,365 cases of malignant neoplasms studied at autopsy, 167 showed skeletal metastases—an incidence of 12 per cent. Symmers (2), in a comparable series of 298 malignant cases, found secondary deposits in bone in 35 cases (12 per cent). Joll (3), at the London Cancer Hospital, reported an incidence of 4.8 per cent. Many other reports covering large series yield little or no information as to the incidence of skeletal metastases. Giles (4) reports 69 cases of skeletal metastases diagnosed entirely on roentgenographic and clinical findings. Geschickter and Copeland (5), in approximately 5,000 cases of cancer, found 334 instances of skeletal metastases (an incidence of about 7 per cent), 37 of which were of undetermined origin. The incidence of skeletal metastasis in a clinical series is, of course, lower than that found in autopsy material because of the advanced character of the disease in the latter. This is more than offset by the fact that, in a clinical series, there is a much larger number of cases having a high incidence of skeletal metastases, such as carcinoma of the prostate and breast. However, no reliable estimates can be obtained from the clinical material alone.

In subsequent paragraphs an attempt is made to summarize our findings and to point out that estimates of the incidence of skeletal and pulmonary metastases fall far short of actuality, and that as regards skeletal manifestations, the problem rests primarily with the roentgenologist. No regard is given to the distribution and type of metastases, because it is believed they bear no definite relationship to the primary growth.

Hitherto negligible sources for skeletal metastases, such as carcinoma of the esophagus, present astonishing findings in our series. In 83 cases, seven instances of bone metastases were recorded, an incidence of 8.4 per cent. Only on occasion have

single cases been reported in the literature (Halluin, *et al.* (6), Jenkinson (7), Copeland and Geschickter (5)). Indeed, Jenkinson was able to collect only 41 cases of skeletal metastases from carcinoma of the gastrointestinal tract in the entire literature up to 1924. In our series alone, 16 cases were found. In 1,600 cases of carcinoma of the stomach, seen at the Mayo Clinic in 10 years, only one instance of skeletal metastasis was found; however, Sutherland and his co-workers (8), from the same Clinic, in a later contribution, found 20 cases, comprising an incidence of 1.9 per cent. Matthews (9) found eight instances of skeletal metastases from the stomach in 309 cases.

In 23 cases of lymphosarcoma, seven showed skeletal involvement, an incidence of 30 per cent. In 164 cases reported by Craver and Copeland (10), an incidence of 10.4 per cent was found. As regards myelogenous leukemia, Craver and Copeland found only one case in 83 with heteroplastic deposits in bone; whereas five cases in 74 were noted in our series (6.6 per cent), a total of 7.4 per cent in 94 cases. This includes 20 cases of lymphatic leukemia, in which two presented heteroplastic skeletal involvement. Hodgkin's disease showed an incidence of 13 per cent in 39 cases, which is in fair agreement with that observed by others (Baldridges and Awe, 13 per cent; Uehlinger, 33 per cent; Barron, 20.8 per cent; Kimpel and Belot, 12.1 per cent). The largest series, by Dresser (11), gave an incidence of 10.7 per cent in 149 cases.

Carcinoma of the liver (cholangiocellular and hepatocellular) presented an incidence of 11.5 per cent (three cases in 26). Rarely have single instances been reported

TABLE I.—SKELETAL AND PULMONARY METASTASES IN 1,365 AUTOPSIES FOR 10 YEARS* (1929–1938, INCLUSIVE)

Condition	Cases			Skeletal Metastases		Pulmonary Metastases	
	No.	M.	F.	No.	Percentage	No.	Percentage
Ca. of large intestine	159	109	50	1	0.62	23	14.4
Ca. of lungs	150	129	21	36	24.0	54	36.0
Ca. of stomach	85	70	15	1	1.2	15	18.8
Ca. of esophagus	83	78	5	7	8.4	26	31.3
Ca. of prostate	97	97		20	21.0	24	25.0
Ca. of cervix	80		80	2	2.5	14	18.9
Ca. of breast	77		77	27	35.0	58	75.0
Ca. of pancreas	69	52	17	3	4.3	12	17.4
Ca. of bile ducts	61	46	15	1	1.6	12	20.0
Acute myelogenous leukemia	56	36	20	2	3.5	1	1.7
Ca. of kidney	47	36	11	10	21.2	37	78.8
Ca. of tongue, lip, and tonsil	41	37	4	2	4.8	7	17.0
Hodgkin's disease	39	31	8	5	13.0	11	28.0
Ca. of ovary	39		39	1	2.5	8	20.0
Ca. of gall bladder	38	18	20	0	0	7	18.4
Ca. of liver	26	21	5	3	11.5	11	42.0
Ca. of urinary bladder	23	16	7	4	17.4	1	4.3
Lymphosarcoma	23	22	1	7	30.4	9	39.2
Ca. of uterine fundus	22		22	3	13.6	7	31.0
Chronic myelogenous leukemia	18	11	7	3	16.0	1	5.5
Ca. of testes	16	16		4	25.0	11	70.0
Sarcoma of bone	16	12	4	2	12.5	8	50.0
Chronic lymphatic leukemia	15	14	1	1	6.6	1	6.6
Ca. of larynx	15	13	2	0	0	0	0
Ca. of nasopharynx	15	14	1	3	20.0	1	6.7
Ca. of thyroid	14	8	6	6	42.8	6	42.8
Ca. of small intestine	10	7	3	0	0	0	0
Ca. of skin	10	8	2	4	40.0	4	40.0
Melanoblastoma	8	5	3	3	37.5	5	62.5
Ca. of adrenal gland	8	5	3	5	62.5	2	25.0
Acute lymphatic leukemia	5	4	1	1	20.0	1	20.0
Totals	1,365	915	450	167	12.0	377	27.6

* From the files of the Cook County Hospital, Dept. of Pathology. A number of these patients showed both skeletal and pulmonary metastases.

in the literature (Brodin (12), Geschickter and Copeland (5)). In 69 cases of carcinoma of the pancreas, three were found to have bone deposits. Only one reported instance was found in a large series reviewed.

In 16 cases of osteogenic sarcoma examined at autopsy, two cases of distant skeletal metastases were recorded (humerus to vertebræ, and innominate to skull).

Carcinoma of the testes presented four cases in 16 with metastases to bone (25 per cent). Thorek (13) cites Mauclaire as reporting only one instance of skeletal metastasis in 81 cases; whereas Copeland and Geschickter report one instance in 42 teratomas and one in 13 seminomas, a total incidence of 3.6 per cent.

In epidermoid carcinomas from the oral cavity, nasopharynx, and skin, seven instances of skeletal metastases in 25 cases were found (28 per cent). Giles reports eight cases, but some of these were probably extensions from the primary site, and not true metastases. Joll stresses the point that squamous-cell carcinoma has a considerable tendency to metastasize to bone, and that this is not sufficiently appreciated.

In 23 cases of carcinoma of the urinary bladder, four instances of skeletal metastases were noted; whereas only single, rare instances have hitherto been reported.

In 150 cases of bronchogenic carcinoma, 36 cases (24 per cent) were found with skeletal metastases. Ewing (14) quotes Adler as citing an incidence of 15 per cent in 374 cases. Grove and Kramer (15) in 21 cases found 29 per cent to have metastases to bone.

Other estimates in our skeletal series are correspondingly high. In carcinoma of the thyroid, six of the 14 cases showed skeletal involvement (42.8 per cent). Ehrhardt (16) found 18 per cent; Kaufman (17), 37 per cent; Neusser (18), 36.9 per cent. Moore (19) found only two instances of bone metastases in over 200 cases of carcinoma of the thyroid. Interstossier, quoted by Ginsburg (20), found 20 per cent of skeletal metastases in 50 cases. Carcinoma of the adrenal gland showed five out of eight cases to have bone metastases (62 per cent); Neusser found 50 per cent. Skeletal metastases were found in three of eight cases of melanoblastoma, an incidence of 37.5 per cent; Copeland and Geschickter, in 169 cases, found 1.7 per cent.

Single cases of bone metastasis from carcinoma of the stomach, extrahepatic bile ducts, ovary, and sigmoid colon are included in our series. There are also two cases of skeletal metastases from carcinoma of the cervix.

A higher incidence of skeletal metastasis is undoubtedly found in autopsy material, but it is fair to assume that these metastatic foci are present long before the case comes to autopsy and can be found when a diligent search is made. Whether unrecognized skeletal metastases may, in some measure, explain deaths from relatively insignificant primary growths is not clear, but certainly a profound effect is exerted on bone-marrow function.

Pulmonary Metastases.—In our entire series, 359 presented metastases to the lung or pleura or both, an incidence of 27.6 per cent. Farrell, in 78 autopsy cases in which secondary malignant disease was noted in the lung, found 9 per cent from the breast (our series showed 14.57 per cent); from the gastro-intestinal tract, 27 per cent (our group, 18.1 per cent). His series also included 12 cases of sarcoma and single instances of melanoblastoma, teratoma testis, pleural endothelioma, etc. This illustrates wide differences in the selection and chance occurrence of lesions in postmortem material.

A detailed analysis of our pulmonary series, with comparisons, is unnecessary, because the pathologist finds the maximum possible incidence. The roentgenologist can only approach his percentages.

Pathologic and Roentgenographic Correlation.—A roentgenographic analysis of our prostate cases when viewed in the light of careful postmortem studies is indeed illuminating.

There were 97 cases of carcinoma of the

prostate, 23 of which were early unsuspected cases found incidentally at postmortem. In three of these skeletal metastases were found with no other metastatic involvement, not even the regional lymph nodes. Of the remaining 74 cases studied, 33 cases presented postmortem findings of metastases to the skeleton, lung, pleura, or intrathoracic lymph nodes. X-rays were taken in 24 of these 33 cases (70 per cent). In 16 cases there were diagnostic roentgenographic findings (54 per cent), in 15 cases there were diagnostic skeletal findings, and in five cases there were definite diagnostic pulmonary findings. If indirect roentgenographic evidence were included in the latter, there would then be seven more instances in which metastatic malignancy might be inferred.

On the other hand, a summation of the postmortem findings reveals a somewhat higher incidence of skeletal metastases because of the roentgenographic assistance given the pathologist. The intrathoracic[3] findings at necropsy were about double those reported roentgenographically.

Of the 74 prostate cases studied, 20 of the 33 positive cases presented skeletal metastases (60 per cent) compared to 15 of 24 observed roentgenographically (60 per cent). In eight instances the skeleton alone was involved.[4] There were intrathoracic metastases in 24 cases (70 per cent) as compared with 50 per cent observed roentgenographically. In 13 of these cases there were no skeletal metastases and 9 of them involved the lung parenchyma. This is surprising in view of the opinions expressed by Bumpus, and others, who hold that pulmonary metastases probably never occur without associated skeletal involvement. It is difficult to reconcile such findings with any rule of behavior. In fact, in one of our cases, the first clue of a cancer of the prostate came from a supraclavicular node.

Neusser (18) and Levin estimate the incidence of skeletal metastases from carcinoma of the prostate as 70 per cent and 66 per cent, respectively; Cone (22) reports an incidence of 60 per cent in 70 cases; Kaufman is quoted as finding 41 per cent in 24 cases. These findings would indicate that the prostate is by far the greatest source of skeletal metastases. It is quite likely that these high estimates are not dependable criteria in large series. In Cone's estimates, a number of his cases were direct extensions from the primary site. It is also possible that there has been a considerable selection of material in small series. On the other hand, Copeland and Geschickter, in 1,020 cases of carcinoma of the prostate, report an incidence of only 12 per cent. Only 50 per cent were roentgenographed, less than 20 per cent showed skeletal involvement. Bumpus (23) reported 41 cases of bone metastases in 362 cases of prostatic carcinoma, of which 135 had x-ray examinations, an incidence of 30.3 per cent of roentgenographed cases. Our series coincides with the latter groups, showing a 21 per cent incidence in 97 cases.

A similar analysis of our breast series reveals that of 77 cases of carcinoma of the breast, 63 cases presented findings of skeletal or intrathoracic involvement (81 per cent). Of these cases, 39 were x-rayed. Three cases were negative roentgenographically. In 16 instances, there were positive roentgenographic findings in the intrathoracic structures, and 17 showed definite skeletal metastases. Four cases showed definite involvement of the mediastinal and hilar lymph nodes. In eight cases there were metastases to both the skeleton and the lungs.

When the necropsy findings are analyzed in comparison, we find that 27 cases presented metastases to bone (36 per cent), whereas 43 per cent of those roentgenographed were positive for bone metastases. In eight instances the intrathoracic structures were spared. In view of such findings it is certainly unwarranted to suppose that skeletal metastases are late manifestations. It is of further interest to note that the roentgenologist found a higher incidence of

[3] Includes lung, pleura, mediastinal and hilar lymph nodes.

[4] Roentgenographically visible involvement. This does not include regional lymph nodes.

skeletal metastases than the pathologist. Intrathoracic metastases were found in 58 cases (78 per cent) as compared with only 41 per cent observed roentgenographically. Of these, 34 cases showed no skeletal involvement. In no case were the mediastinal and hilar lymph nodes alone involved.

In 757 deaths in cases of carcinoma of the breast, recorded at the Surgical Pathological Laboratory, of the Johns Hopkins Hospital, up to 1930, only 89 cases (11.8 per cent) were found with skeletal metastases. Gross (24) found an incidence of 20.5 per cent; Carnett (25), 49.5 per cent; Kaufman, 53 per cent in 63 autopsies.

There is no need to stress the importance of exhausting all possible criteria for the recognition of skeletal involvement, since prognosis and treatment are critically affected. The pathologist cannot investigate the entire skeletal system at necropsy and the roentgenologist only occasionally makes an adequate study. Furthermore, skeletal and pulmonary metastases are not sufficiently symptom-producing to attract even the clinician. On the other hand, pain may precede an observable skeletal lesion by from three to 18 months. It may be surmised that skeletal manifestation after surgery is, in many instances, evidence of omission on the part of the surgeon and roentgenologist, since, generally, many months are required for a skeletal lesion to assume obvious proportions. It is at this juncture that painstaking observations should be made. This study serves to indicate that we may be too optimistic about the curability of cancer and thereby actually diminish the patient's life expectancy by radical surgical procedures when existing skeletal metastases are not obvious. Indeed, Levin (21) points out that in at least 10 cases of carcinoma of the breast under his observation skeletal metastases were present at the time of operation. It is somewhat debatable to what extent life is prolonged by surgery in the presence of skeletal involvement but it is uniformly agreed that radical surgery is not advisable.

SUMMARY

1. An analysis of the incidence of skeletal and pulmonary metastases, in 1,365 cases of malignant disease coming to autopsy, reveals a considerable increase over previous estimates.

2. The increased incidence of skeletal metastases is attributed to more thorough roentgenographic study and careful postmortem examination.

3. There are no reliable criteria for predicting the behavior of metastatic processes.

4. Skeletal metastases are not infrequently early rather than late manifestations.

5. In carcinoma of the prostate, approximately 27 per cent of the roentgenographically visible lesions are found within the thorax without skeletal metastases.

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DISCUSSION

LEO G. RIGLER, M.D. (Minneapolis, Minn.): This is an exceedingly interesting presentation, but so extensive it is difficult to discuss it with any degree of completeness. However, I want to bring out one or two points.

The first is that the autopsy observation of the incidence of skeletal metastases is worth little. I have yet to see a pathologist, at least in this country, who makes any kind of thorough search of bones, even of the pelvis and spine, in cases of carcinoma of the prostate. My impression of the figure given by Dr. Hubeny and Dr. Mass of 21 per cent is that it is far too low.

In a series which we have just reviewed, consisting of clinical cases, which, of course, are not all confirmed, but in which we have been rather conservative about the diagnosis of carcinoma of the prostate (a quite easy diagnosis, in our experience), over 50 per cent of the patients showed metastases at some time or other during the course of illness. I am sure that this is a conservative figure.

The reverse, of course, is true of pulmonary metastases. There the pathologist has the opportunity to examine the lungs more thoroughly and the roentgenologist is apt to err on the negative side. We have been astonished at these high figures of pulmonary metastases in carcinoma of the prostate. I presume it is because we have been missing them.

In reviewing this series of cases we have been impressed also with the large number of cases of carcinoma of the prostate in which evidences of metastases were the very first sign of the primary tumor, the patient being sent in on account of pain.

I have the definite impression that in many metastases—not all—pain is present before the roentgenologic findings; this, of course, has been well demonstrated by the work of Snure and his co-workers, in Los Angeles. I am sure that we miss many metastases, particularly those in the spine and pelvis, as Snure pointed out so well.

I am convinced, too, that if one examines a patient carefully, evidences of metastases will be produced, particularly if one palpates the bones or percusses them severely. Almost invariably there will be some pain and tenderness over these bones, even though the patient does not volunteer any complaint as to them. In this way a clue may be obtained as to the particular area which must be explored roentgenologically.

MAX MASS, M.D. (*closing*): I cannot agree with Dr. Rigler that the findings of skeletal metastases in postmortem material are of relatively little importance. It is my opinion that at least our attention is directed to the presence of these metastases which we know have been present a long time and might have been recognized if a careful search had been made.

As regards the low percentage of metastases to bone from carcinoma of the prostate in our series, I have observed that in large postmortem services the relative percentages of carcinoma of the prostate are not as great as those found in other types of cancer. Many of our cases were either early carcinomas found incidental to other conditions or instances which death resulted from post-operative complications.

A PRELIMINARY REPORT ON THE USE OF FAST NEUTRONS IN THE TREATMENT OF MALIGNANT DISEASE[1]

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From the Division of Roentgenology and the Radiation Laboratory of the University of California

THE production of fast neutrons in therapeutic intensities and the successful collimation of them into beams has made a new method of treatment of cancer available. It has not been used long enough to report on results. Many radiologists expressed a desire to know how they were being used. Hence, we agreed to make a preliminary report on the method.

Neutrons are electrically neutral particles of matter, each having approximately the same weight as a proton (the nucleus of the hydrogen atom). Chadwick (1) discovered their existence in 1932. For the treatments here reported, they were produced by bombarding a target of beryllium with deuterons (nuclei of heavy hydrogen or deuterium) with energies of eight million volts. The deuterons were given their energies in the Lawrence cyclotron. The method of operating the cyclotron to produce neutrons, and some of the properties of neutrons were described by E. O. Lawrence (2) to the Radiological Society of North America in 1936. In brief, the cyclotron repeatedly applies electrical propulsions to deuterons moving in circular paths in a magnetic field. When the fullest possible energy has been given to the deuterons they are drawn out of the accelerating chamber by a deflecting potential and strike a beryllium target.

This bombardment sets free great numbers of neutrons having energies up to 12 million volts. These radiate from the target in much the same way as x-rays spread out from a target bombarded with electrons. In addition to the neutrons, gamma rays are produced when the deuterons are stopped.

The collimation of these fast neutrons into a useful beam was accomplished by Aebersold (3). In brief, the beam is delimited by an outward tapering channel through a wall of paraffin (or water) over 50 cm. thick. The wall of hydrogenous material surrounds the target so as to protect the whole treatment room. The accompanying gamma radiation was reduced greatly by lining the channel with 3 cm. of lead and by covering the outside of the hydrogenous shield with over 2.5 cm. of lead. Gamma rays from the target are suppressed by a lead filter 3 cm. thick in the channel (Fig. 1).

The proof that a collimated beam was obtained by this device was found by ionization measurements and by the effect onx-ray films. Aebersold (3) found that 5, 10, and 50 cm. from the edge of the beam the intensities were approximately 6 per cent, 4 per cent, and 1 per cent of the intensity in the beam. Photographic mapping of the beam was accomplished by using non-screen x-ray films wrapped in black paper. Figure 2 shows the effect on such a film placed in the beam parallel to the path of the neutrons. The streak down the middle is the shadow cast by a narrow block of paraffin, 3 cm. in thickness, placed at the end of the cone. The sharpness of the edges of the field and of the shadow of the paraffin block demonstrates that the beam is sufficiently collimated to use on patients.

The personnel operating the apparatus was further protected by tanks of water,

[1] Read before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11–15, 1939.

[2] At first supported by the Christine Breon Fund for Medical Research. Now a Fellow of the Finney-Howell Foundation.

3 feet thick, surrounding the whole apparatus and the treatment room. The patients were observed by mirrors.

The problem of measuring the intensity of a neutron beam in units comparable to the roentgen has not been finally solved. For practical purposes, however, a convenient arbitrary unit is that quantity of neutrons which discharges the Victoreen condenser type r meter to the same extent as would one r of x-rays. This unit, so well described by Zirkle and Lampe (4), has come to be called a neutron unit and is abbreviated as n. The instrument is used with the 100 r chamber as it would be in measuring x-rays, but instead of designating the amount as so many roentgens, it is designated as so many neutron units. It must be remembered that this is an arbitrary method and one neutron unit does not represent the same energy absorption as one roentgen. The multiplying factor for obtaining the ionization in tissue caused by neutrons relative to that caused by x-rays is not accurately known at present, but Aebersold and Anslow (5) believe it to be not more than 2.5.

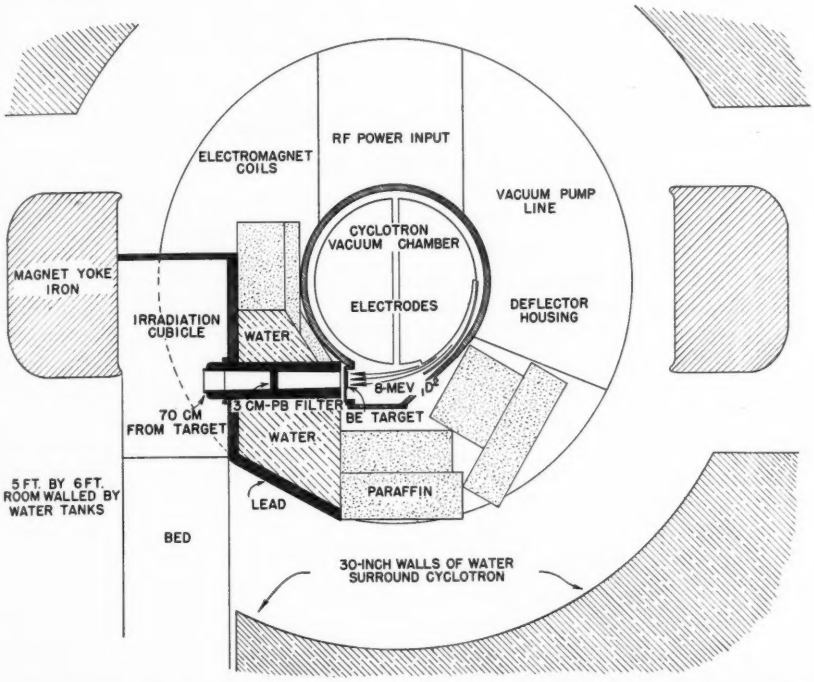

Fig. 1. Horizontal section of cyclotron showing the collimating device and treatment cubicle. (From *Physical Review.*)

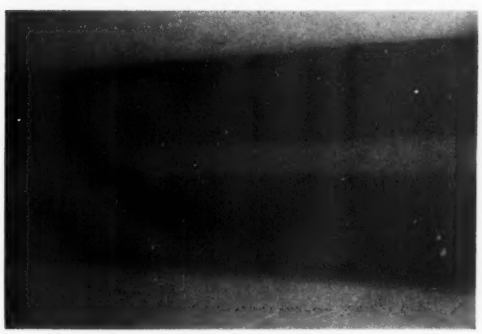

Fig. 2. Reduced reproduction of a film exposed along the axis of the fast neutron beam. The dark area was caused by the beam. The lighter streak in the center of the beam is the shadow cast by a block of paraffin 3 cm. thick, purposely inserted in the mouth of the outlet. The beam had traversed the lead filter, 3 cm. thick, before incidence on the paraffin strip. All edges are sharp, indicating good collimation. (From *Physical Review.*)

The back-scatter at the surface and the per cent depth dose are not known well enough to be discussed. We can state from preliminary measurements and from clinical observations that the depth dose is sufficient for deep therapy.

The dose of neutrons to be used on patients was arrived at by a study of the comparative effects of x-rays and neutrons on biologic indicators. Zirkle, Aebersold, and Dempster (6) and Zirkle and Lampe (4) studied the effects of the two radiations on *Drosophila* eggs, wheat seedlings, and fern spores. In general, they found that while the x-ray dose which reduces the hatching of *Drosophila* eggs to 50 per cent is 180 r the neutron dose which produces the same degree of effect is 87 n, a ratio of 2 to 1. Using wheat seedlings, they found the x-ray-neutron dosage ratio varying from 5 to 1, to 11.8 to 1. With fern spore division as an indicator, they found the dosage ratio to be 2.5 to 1. Lawrence, Aebersold, and Lawrence (7), using Sarcoma 180, found the dosage ratio for similar killing effects by the x-rays and neutrons to be 4 to 1. Snell and Aebersold (8), studying the production of sterility in male mice, found a ratio of 5 or 6 to 1. Marshak (9), studying the effect of fast neutrons on chromosomes in mitosis, found an x-ray-neutron dosage ratio of 6 to 1, using such varying tissues as root tips and mouse tumors. Aebersold (3) studied the epilation of the backs of rabbits and found a dosage ratio of 3 or 4 to 1 (Fig. 3). From these results it is seen that the relative sensitivities of the different biologic indicators are not the same.

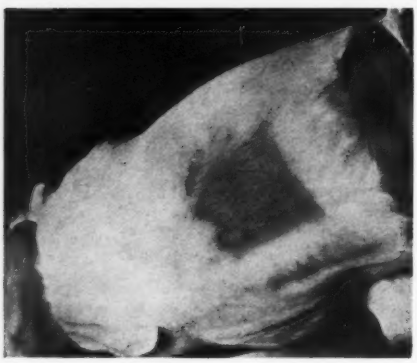

Fig. 3. Epilation produced on the back of a rabbit after exposing it to a dose of 400 n. The epilation started in two weeks and was complete after six weeks. The effect is seen to be sharply limited. (From *Physical Review*.)

After considering the above dosage ratios, it was finally decided that the number of neutron units that could be tried with safety on a patient would be about one-quarter the number of roentgens of 200 kv. x-rays that would be required for a given erythema. The first patient was a man with a carcinoma of the upper alveolar ridge (gum) invading the maxilla. On Sept. 26, 1938, he was given 180 n through a field 10 × 10 cm. in size over the left side of his face. On the third and fifth days he had a transient slight erythema. On the tenth day he had a definite persisting demarcated erythema which reached its height about the twenty-fourth day. It became brown-red by the thirtieth day and gradually faded to no color on the forty-third day, and the skin appeared normal on the fifty-seventh day. The hair commenced to fall out about the thirtieth day and epilation became complete. Thus, the dose of 180 n produced much the same effect as we would have expected from 900 roentgens of 200 kv. x-rays.

From September, 1938, until June, 1939, the cyclotron was available one day a week. Consequently, the patients were given single large doses. Fractionated treatments were not possible and it was felt advisable to try to find the "erythema" dose and observe its effect on the skin, mucosa, and tumor. Because of the physical arrangements, it was possible to treat only areas from the mid-thorax to the head, and the left forearm. The voltage of the bombarding deuterons was constant at eight million. The intensity of the neutron beam varied from 1.4 to 4 n per minute with a usual average of 3 n/min., so that it took about one hour for each treatment.

Twenty-four patients were treated. Several of them were treated over more

than one field but on different days. Some of the fields were treated more than once, after the first effect wore off. Sixty-four separate treatments were given. The amount given per treatment varied from 60 n to 275 n. No second degree erythemas were produced. Two sizes of fields were available, 10 × 10 cm. and 7 × 7 cm., the larger being used most of the time.

In general, it was found that doses of 180 to 200 n administered to fields 10 × 10 cm. in size to the side of the face and neck always produced a moderate erythema which appeared between the seventh and eleventh days, deepened until about the twenty-first day, gradually changed from erythema with dry scales to pigmentation, and left very little residual change after a few months (Fig. 4). Epilation was always produced but varied in the time of its appearance, the average being 28 days. Doses up to 270 n did not produce blistering but did produce deeper erythemas and more marked scaling. As far as it was possible to contrast these reactions with x-ray reactions, it may be said that there appeared to be more thin, dry flaking of the outer layers of the skin for the same intensity of erythema. The erythemas appeared earlier than would be expected for similar x-ray erythemas.

Eighteen treatments were given to areas previously treated with neutrons or x-rays, but only after the first reaction had completely subsided or persisted only as pigmentation. In these instances, the amount given varied from 125 to 270 n. All patients experienced about the same course of reaction as mentioned above except that they reached the height of their reaction in about 18 days. The variations in response were greater from patient to patient than from one dose to another.

Patients treated about the face and neck received the following doses: 120 to 140 n, 7; 170 to 199 n, 14; 200 to 229 n, 16; 230 to 259 n, 6; 260 to 270 n, 3.

Eight treatments were given to the upper chest and clavicular region with doses varying from 180 to 275 n. These treatments produced the same course of reaction in the skin as those to the face and neck, but the degree of the reaction for the same dose was not quite so great.

Eight of the patients were followed for more than one year. The late effects for that time have been very similar to the late effects after x-ray treatments of similar biologic amounts. In the neck edema and swelling occurred producing varying degree of "wattles." Some showed subcutaneous fibrosis as judged by palpation. Blotchy pigmentation and depigmentation have been observed. No telangiectasis has been seen as yet.

In an attempt to find the dose required to produce the minimum threshold pigmentation, 10 treatments were given to the flexor surface of left forearms using fields 7 × 7 cm. in size. Four received 70 n, three 80 n, one 90 n, and two 100 n. The number of these is far too small to enable us to reach any definite conclusion, but we believe that a minimum threshold pigmentation will probably be produced by about 90 n (air measure). This reaction is similar to that described by Quimby

Fig. 4. A patient 24 days after receiving 250 n of fast neutrons to a field 10 × 10 cm. in size.

as occurring with 525 r (measured in air) of 200 kv. x-rays.

The mucosal reactions observed in the oral and pharyngeal cavities were similar to those produced by x-rays but we have not had the opportunity to observe many mucosal reactions to single erythema doses of x-rays. The time of appearance varied from 6 to 14 days and the height of the reaction was reached about the fourteenth day. The reactions cleared up by the twenty-first day.

In considering the reactions of the tumors, it must be remembered that only patients with advanced lesions were treated. The criterion of acceptance for treatment was that the disease was so far advanced that the patients had no chance of being cured by treatment with radium, x-ray, or surgery. All had palpable lymph nodes believed to be invaded by carcinoma, as well as advanced primary lesions. The locations of the carcinomas were as follows: Lateral wall of pharynx, 6; nasopharyne, 2; alveolar ridge, 2; tongue, 3; palate, 1; cervical metastases from intra-oral or lip lesions, 4; face, 2; recurrent breast, 1; lung, 3.

In every case there was some decrease in the size of both the primary lesions and the metastases. The six extensive ulcerating necrotic lesions of the lateral pharyngeal wall responded very little but the cervical metastases from these decreased markedly. The carcinoma of the soft palate disappeared for a few months but recurred. Two of the bronchogenic carcinomas responded quite poorly. As with x-rays, the nasopharyngeal lesions responded very well. The most promising results were those obtained on the neck metastases. Those cases which had had previous x-ray therapy responded least of all, as was to be expected. Both skin carcinomas were far advanced and had had previous x-ray treatments. Eight patients have lived more than one year, but all still have their tumors.

It must be emphasized that the treatments given were single erythema doses. They were not even skin tolerance doses and were not fractionated.

The same general reactions followed the treatments with neutrons as follow those with x-rays. Most of the patients presented one or more of the following symptoms: weakness, anorexia, nausea, and vomiting.

In the Fall of 1939, a new cyclotron was completed to be used largely for clinical purposes. Hence it was available for fractionated treatments. It operates so as to produce deuterons with 16 million volts energy. The target–skin distance is 100 cm. The paraffin shield is over 70 cm. thick and it is surrounded by 4 inches of lead. The amount of neutron radiation given per sitting is now about 50 n at the rate of 5 n/min. or more. Treatments are given three days each week. It is too soon to speak of results, but the immediate responses are greater than before and the general reactions of the patients are less marked. Total doses have been greater and have resulted in some cases in a second degree epidermitis.

CONCLUSIONS

Patients have been treated with collimated fast neutron beams so as to produce tumor responses without undue damage to the skin or other normal tissues.

The results so far are sufficiently promising to warrant an extensive and thorough trial of this new method of treating cancer.

For the use of the cyclotron and for much stimulation in this work we are greatly indebted to Professor E. O. Lawrence and to his staff of co-workers in the Radiation Laboratory. The construction of the cyclotron and its operation for this clinical problem have been made possible by grants from the Chemical Foundation, the Research Corporation of America, the Rockefeller Foundation, and the Works Progress Administration. It is at present largely supported by the National Advisory Cancer Council of the U. S. Public Health Service and the continuance of the clinical work is due to their co-operation.

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DISCUSSION

FRED J. HODGES, M.D. (Ann Arbor, Mich.): For Dr. Stone I have nothing but the highest praise. Every time he talks I hold him in greater and greater esteem. In the last few years he has certainly made his mark for all time by clarifying many questions concerning the clinical use of supervoltage x-ray and neutron radiation. He is a never-failing source of valuable information.

Dr. Stone has remarked about the fact that in 1896 no one could have prophesied the future of therapeutic irradiation. From that observation he has extracted a valuable lesson and has presented to us, in review, a methodical, thrilling, and absorbing attack upon the problems of x-radiation as a parallel to the use of neutrons. Many of the blind alleys investigated in a more or less haphazard way in the case of x-rays will not be explored with such great loss of time and effort in the case of neutrons.

Dr. Stone has graciously acknowledged the courtesy of his friends in physics in connection with neutron experimentation and the building of cyclotrons. We have experienced the same co-operative attitude in spite of the annoyance which our slow and halting experiments have caused. In comparison with the rapid technical advances in Berkeley, our equipment at Michigan is awkward and cumbersome for biologic experimentation. Instead of utilizing the neutron beam which comes directly from the beryllium window, it is necessary for us to ask that the vacuum tank be opened to permit the introduction of a special beryllium probe in order that we may have a neutron beam of sufficient intensity for our purposes. I can well imagine the annoyance we would feel in the department of roentgenology if anyone asked similar favors of us, and yet our physicists continue to be considerate and co-operative.

MULTIPLE CYSTIC TUBERCULOSIS OF BONES: ITS ROENTGEN PICTURE AND REPARATIVE PROCESS AS SEEN IN SERIAL ROENTGENOGRAMS

By JOHN L. LAW, M.D., *Ann Arbor, Michigan*

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DURING the past four years I have had the opportunity of closely following the healing process, through roentgenograms, of widely disseminated cystic bone lesions of tuberculous origin in a young girl. A complete clinical report of this case has been given in another journal (1). The present communication concerns itself mainly with the roentgen picture.

The present concept of multiple cystic bone tuberculosis, "osteitis tuberculosa multiple cystica," is applied to a comparatively rare form of diaphysial bone tuberculosis, usually multiple, and of metastatic origin from a primary thoracic focus. It is insidious in onset, with few or no localizing signs such as pain, tenderness, or external evidence of inflammation. The lesions run a chronic benign course, consist of a circumscribed area of soft tuberculous granulation tissue and degenerated bone which tend to heal slowly. The roentgen picture is fairly characteristic and of distinct diagnostic importance.

Two main roentgen types are described; the diffuse and the circumscribed (2, 3).

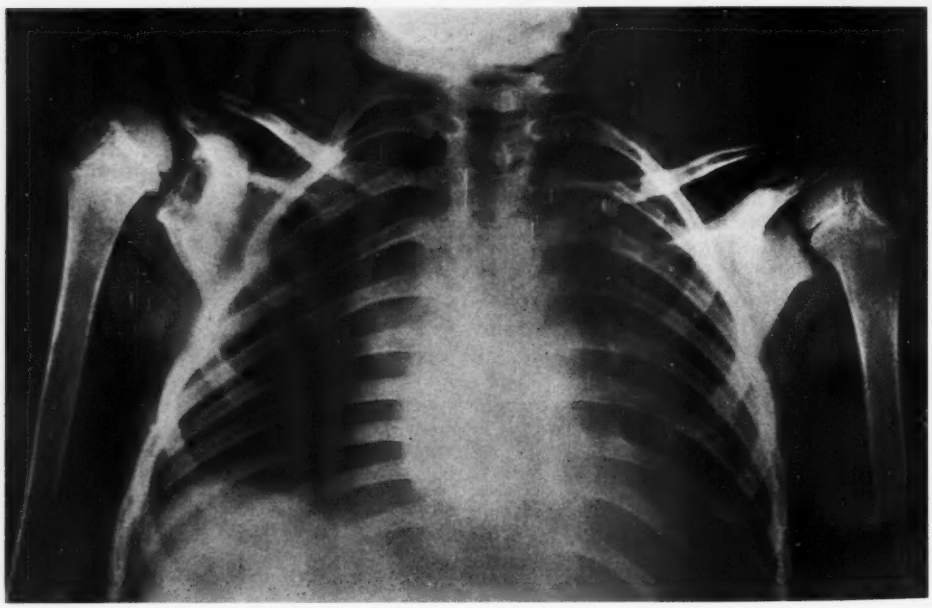

Fig. 1. Circumscribed area of rarefaction in the lateral tip of the right clavicle and the median third of the left clavicle. Rarefaction and change in the architectural structure of the body and supraspinatous part of the right scapula. Destructive lesion in the region of the glenoid process of the right scapula. The distal third of the right acromion process contains a circumscribed area of rarefaction. Irregular circumscribed lytic area in the superior angle of the left scapula. The distal third of the left acromion process shows a similar lesion. Circumscribed small oval area of rarefaction at the extreme proximal end of the left humeral diaphysis with minimal peripheral sclerosis. An irregular area of rarefaction involving the lateral superior aspect of the right humerus on each side of the epiphyseal line is seen. (Film made March 27, 1935.)

The diffuse is the more acute initial stage. In it, the diaphysis cannot be differentiated into medulla and cortex. Here the cystic areas of decreased density are honeycombed with a web-like structure of increased density. The individual or several apertures in the web vary in size from that of a millet seed to that of a pea. The cystic areas may enlarge to include both medulla and cortex, increase the diameter of the involved bone, and cause destruction of a phalanx.

The patient presented demonstrates the *circumscribed* type. In typical cases the roentgenogram shows round smooth or irregular punched-out like areas of decreased density, with a thin cortex and little or no surrounding sclerosis. There is usually no involvement of the periosteum, no cortical expansion, and no abscess or sequestrum formation.

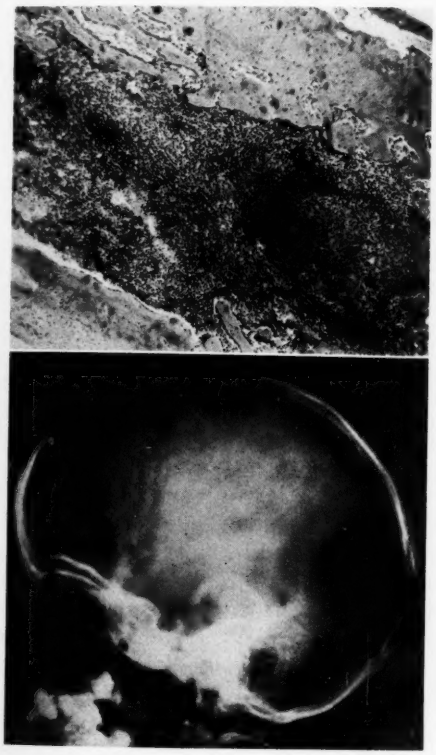

Fig. 2 (*above*). Photomicrograph (low power) of biopsy specimen of right scapular region, taken May 5, 1935. Report of C. V. Weller, M.D. Numerous small fragments of bone were recovered. After decalcification, these showed an active tuberculosis, involving periosteum and perichondrium. Likewise, in spaces within the bone, tuberculosis granulation tissue with numerous giant cells and discrete tubercles were found. The histologic evidences are characteristic for non-caseating tuberculosis.

Fig. 3 (*below*). Several small circumscribed rarefied lesions located at the reflection of the sphenoid ridges of the lateral wall of the skull on each side. (Film made March 28, 1935.)

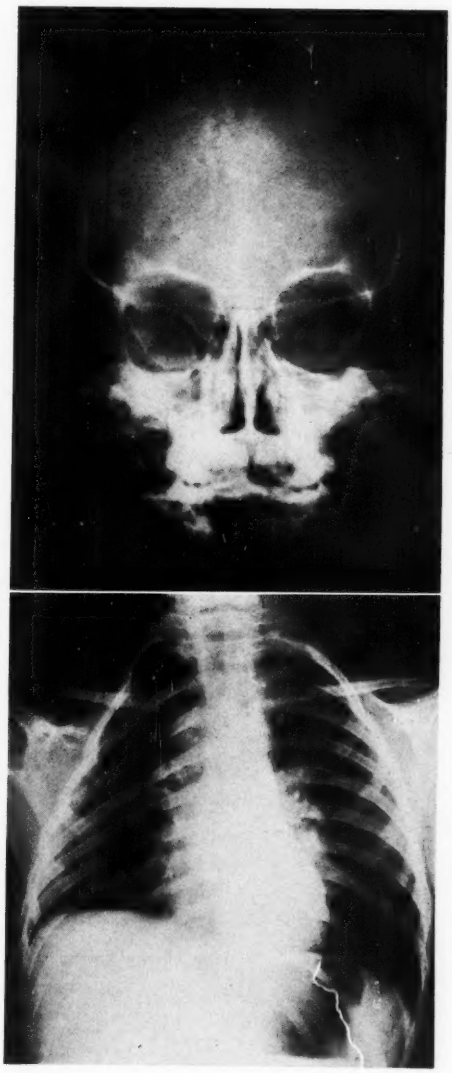

Fig. 4 (*above*). Four small areas of rarefaction are seen in the frontal skull projection.

Fig. 5 (*below*). Gross tuberculous adenopathy, peribronchial and peritracheal; no parenchymal focus.

The roentgen picture of these circumscribed lytic tuberculous lesions is not only characteristic but, in the general absence of any localizing physical signs, the diagnosis of multiple cystic bone tuberculosis is contingent on roentgen bone examination in children who have tuberculous thoracic disease. Without roentgen bone examination, the far-flung lytic lesions in my little patient would not have been suspected or detected.

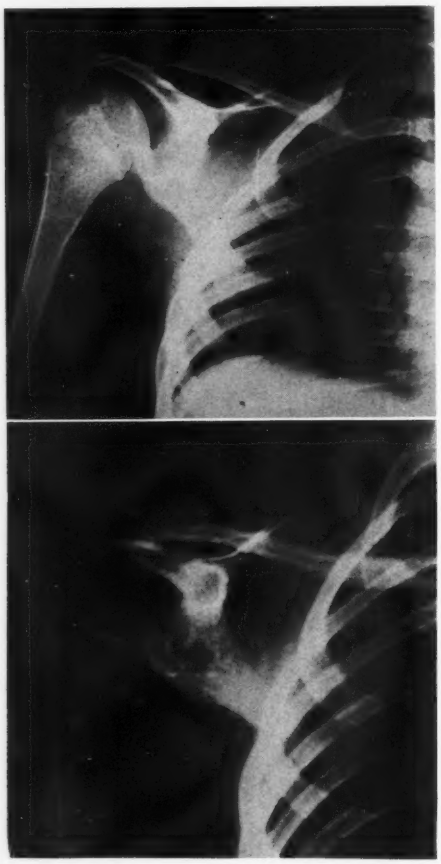

Fig. 6 (*above*). The lesion in the lateral tip of the right clavicle and in the distal third of the right acromion process have healed. There is slight advance in the destructive process in the glenoid of the right scapula. There is considerable advance of the lesion in the lateral superior aspect of the humerus. (Film made in October, 1936.)

Fig. 7 (*below*). There is some advance in the process involving the glenoid fossa. Slight progression of the lesion in the head of the humerus. (Film made in May, 1937.)

In March, 1935, a six-year-old girl was admitted to the Pediatric Service, University Hospital, with an immediate history of kyphotic deformity of the spine which had not improved after three months' treatment in a cast.

At the time of admission she was fairly well developed and nourished. Mid-thoracic kyphosis, protuberance of three vertebræ, and some local tenderness were the only positive signs. They justified a diagnosis of spinal tuberculosis which was confirmed by roentgen examination. Figure 1 shows the widely scattered lytic lesions in the bones related to the thorax. These areas of rarefaction were unsuspected. Their presence led to a complete roentgenologic examination of the skeletal system and to laboratory tests to prove their etiology.

The complete skeletal roentgenologic examination revealed punched-out or irregular circumscribed areas of rarefaction in the following sites: both scapulæ, the right and left clavicles, the skull, the left humerus and the left radius, the right humerus and the right radius, the first, fourth, fifth, sixth, and ninth left ribs, the left iliac bone, the third and fifth lumbar vertebræ, the right and left tibias, and in the left fibula.

The laboratory data showed a 1/1000 Mantoux tuberculin test to be 2+, the urine, blood, and Kahn tests negative, the blood calcium, phosphorus, cholesterol, lipids, and sugar within normal limits.

Microscopic study of the biopsy material obtained from the right scapula showed tuberculosis (Fig. 2).

In view of the positive tuberculin test, the tuberculous spinal lesion, the hilar adenopathy, the biopsy findings, the negative ancilliary laboratory tests, and the characteristic roentgen appearance of the lesion, a diagnosis of multiple cystic bone tuberculosis was made.

For over two years the basic treatment within and without the hospital consisted of commonly used supportive dietetic measures, a body cast, and Bradford frame care. This régime was interrupted at eight

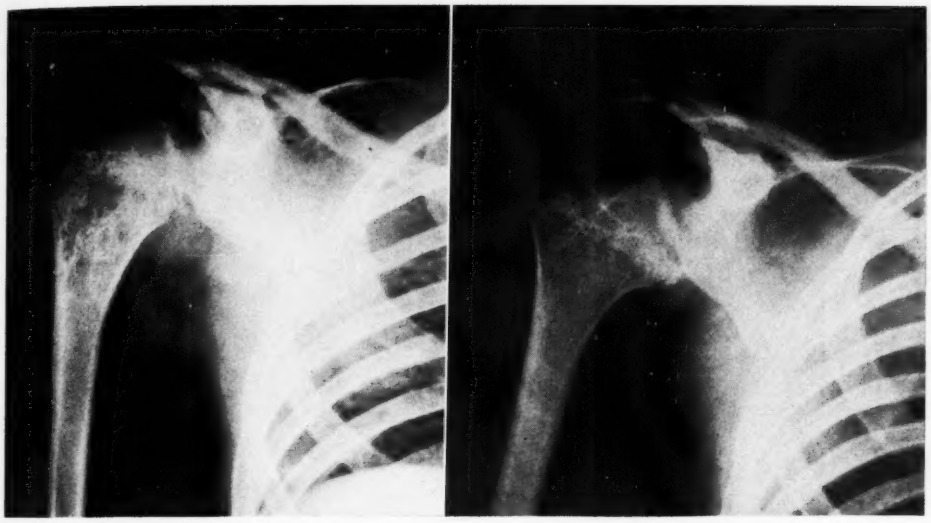

Fig. 8. Fig. 9.

Fig. 8. The destructive lesion involving the head of the humerus and the glenoid in the scapular shows slight regression. (Film made May 18, 1938.)
Fig. 9. Smoothing of the articular surfaces and loss of the irregular destructive appearance indicate almost complete repair of the head of the humerus and the glenoid fossa. (Film made March 24, 1939.)

and one-half months by a Hibbs spinal fusion. At 27 months the patient was transferred to a tuberculosis sanatorium at Howell, Michigan, to break contact with infections in a general ward for children. With similar therapeutic care at the sanatorium it was possible to replace the body cast at 38 months with a Taylor back brace, and to allow limited activity. At 48 months, bony spinal fusion was complete, the back brace was omitted, and normal activity permitted. While in the sanatorium occasional small amounts of mucoid sputum were found to be positive for tubercle bacilli, though serial lung roentgenograms showed no activity.

During a period of four years' supervision the general physical improvement and the specific bone repair were gradual and steady. There was an occasional interruption signified by lassitude and an elevated temperature. The physical improvement is shown in a weight gain of 54 pounds. The reparative process in the skeletal lesions is best demonstrated in the serial roentgen studies of the bones involved.

Skull.—The punched-out areas in the skull are seen in Figures 3 and 4. These areas healed in seven months.

Lungs.—Gross hilar adenopathy is seen in Figure 5. Moderate accentuation of

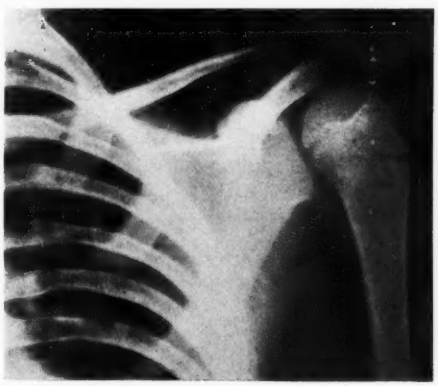

Fig. 10. The lesion in the superior angle of the left scapula, the distal third of the left acromion process, and the extreme proximal end of the left humeral diaphysis shows complete clearing. (Film made March 25, 1937.)

the hilar shadow was present seven months later. The hilar adenopathy had cleared at 11 months. A roentgenogram of the chest is shown in view of the probable metastatic origin of disseminated cystic bone lesions from an intrathoracic primary infection.

Clavicles.—A single lesion in each clavicle showed complete healing in five and one-half months (Figs. 1, 6, and 10).

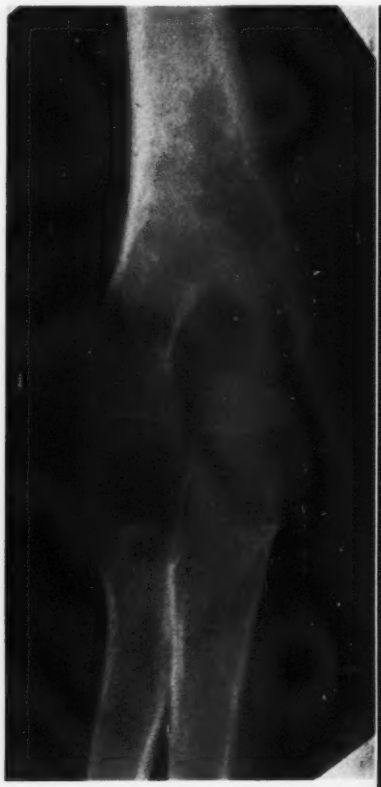

Fig. 11.

Fig. 12.

Fig. 11. Irregular area of rarefaction at the distal diaphysial end of the humerus (forearm was not included in the roentgenogram). (Film made March 27, 1935.)

Fig. 12. At the distal diaphysial end of the right radius there is a circumscribed area of rarefaction about which there is slight increase in density. (Film made June 8, 1935.)

Right Scapula.—The body, supraspinatus process, glenoid process, and distal third of the acromion showed lesions at the time of admission. The lesion in the acromion healed in six and one-half months. Areas in the glenoid fossa remained stationary for seven months, then showed an advance at 12, 17, and 24 months. At 38 months there was slight regression, while at 48 months healing was almost complete. (Figs. 1, 6, 7, 8, and 9.)

Left Scapula.—A lesion in the superior angle of the scapula (not well demonstrated) and in the distal third of the acromion showed gradual regression over a period of ten and one-half months at which time there was complete healing (Figs. 1 and 10).

Right Upper Extremity.—The lesion in the lateral superior aspect of the head of the humerus showed progression at 17 and 24 months. There was slight healing by 37 months, with almost complete repair at 48 months. (Figs. 1, 6, 7, 8, and 9.) A lytic lesion in the distal diaphysial end of the humerus healed completely in six and one-half months. A lesion in the distal diaphysis of the radius healed slowly, so that at twenty and one-half months there remained only slight architectural change. Three minor new lesions were present at 24 months (Figs. 11 and 12).

Left Upper Extremity.—An area of rarefaction in the proximal end of the humeral diaphysis shows complete healing in 24 months (Figs. 1 and 10). A lesion at the

Fig. 13.

Fig. 14.

Fig. 13. Lateral projection. (Film made March 28, 1935.)
Fig. 14. There is a circumscribed rarefied lesion in the medial anterior margin of the third and fifth lumbar bodies, with sclerotic borders. (Film made March 27, 1935.)

Fig. 15. Lytic lesion with a sclerotic border in the mid- and upper part of the left iliac bone. (Film made April 10, 1935.)

Fig. 16. Rarefied circumscribed lesion with slight sclerosis in the proximal diaphysial end of each tibia; similar lesion without sclerosis in the proximal diaphysial end of the left fibula. (Film made March 28, 1935.)

distal end of the humerus and the proximal part of the radius regressed to complete healing in twelve and one-half months.

Ribs.—In the proximal part of the first left rib, in the vertebral ends of the fourth, fifth, and sixth ribs on the left, and the ninth rib, left posterior, there were areas of decreased density which were irregular in outline. These areas of rarefaction cleared slowly and the lesions in all ribs had healed by 11 months. Reproduction of these minor lesions is not practical.

Upper Spine.—Typical tuberculous lesions in the spinal vertebræ, dorsal region, showed healing in 48 months following a Hibbs fusion and prolonged hospitalization.

Lower Spine.—A circumscribed area of rarefaction in the third and fifth lumbar bodies shows healing in twelve and one-half months (Fig. 14).

Iliac Bones.—The lytic lesions in the left iliac bone healed in six months (Fig. 15).

Lower Extremities.—Healing of the lytic lesions in both tibia and the left fibula took place in twenty and one-half months.

Differential Diagnosis.—If one has seen a typical roentgen film in a case of multiple cystic tuberculosis, the appearance is so characteristic that diagnosis may be made by roentgen study. However, in lesions of doubtful causation differential diagnosis should include the exclusion of tuberculosis, syphilis, osteomyelitis, xanthomatosis, hyperparathyroidism, multiple myeloma, coccidiodal granuloma, leprosy, and enchondroma.

Treatment.—Treatment consisted of individual symptomatic measures combined with a recognized form of general management for tuberculous patients.

COMMENT

In this proven case of multiple cystic bone tuberculosis there was a total of 35 widely disseminated rarefied areas of involvement in 22 distinct bones. None of these lytic lesions involved the small bones of the hands and feet. The circumscribed, punched-out, or irregular lesions were similar to the circumscribed "type" described by Jungling as occurring in the small bones of the hands and feet. Their roentgen appearance was fairly uniform and characteristic of a stage in the disease process. Eleven of the 35 lesions demonstrated slight to moderate surrounding sclerosis. There was subperiosteal new bone formation adjacent to an area of rarefaction in the distal medial epicondyle of the left radius. The reparative process as determined through serial roentgen examinations proceeded uniformly in most of the affected areas. Healing took place in

TABLE I.—SUMMARY OF THE SITE, NUMBER OF LESIONS, AND TIME OF HEALING

Site	No. Lesions	No. Bones Involved	No. Sclerotic Areas	Time of Healing (mos.)
Skull	7	3	3	7
Clavicles	2	2		$5^1/_2$
Right scapula	3	1		$6^1/_2$–48
Left scapula	2	1		$10^1/_2$
Right upper extremity	6	2	1	0–$6^1/_2$
Left upper extremity	3	2	1	24–48 $12^1/_2$–24
Lower spine	2	2	2	$12^1/_2$
Iliac bone	2	1	2	6
Lower extremity	3	3	2	$20^1/_2$
Ribs	5	5		11
Total	35	22	11	$5^1/_2$ to 48

from five and one-half to 48 months (Table I).

SUMMARY

1. A description of the roentgen appearance of the two main stages, "types," diffuse and circumscribed, of multiple cystic bone tuberculosis is given.

2. It is pointed out that the roentgen picture is characteristic and of diagnostic importance.

3. In a rare case of circumscribed multiple cystic bone tuberculosis in a six-year-old female the reparative process of 35 widely scattered lesions is demonstrated by serial roentgen studies over a four-year period.

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THE CLINICAL APPLICATION OF URINARY DYNAMICS[1]

By E. L. SHIFLETT, M.D., *and* D. Y. KEITH, M.D., *Louisville, Kentucky*

CLINICAL application of intravenous urography makes it necessary to consider normal and pathologic morphology and physiology of the entire urinary tract. Adequate analysis of intravenous urograms necessitates a division of the physiologic activity into secretion, or filtration which cannot be directly visualized, and dynamic excretion, or the transportation of urine which can be demonst ated. Dynamics vary markedly and sometimes almost specifically in various disease entities and emphasis on these variables permits intelligent interpretation and clinical application of the information revealed. The study is best approached by stressing urinary peristalsis. We do not believe this dynamic function can be studied advantageously when compression or other artificial interference is employed.

There are unknown physiologic, neurogenic, and anatomic factors which enter into normal renal function and there is some speculation and theorizing as to the mechanism by physiologists, anatomists, and medical writers. Much of this unknown quantity does not readily lend itself to experimental investigation because the very attempt to do so creates an abnormal physiologic state in a highly sensitive system. However, it is helpful to attempt an explanation of some of these factors by a correlation of visualized function and clinical symptoms in the present state of individuals suffering from various urinary diseases and, if possible, to apply them to urographic diagnosis.

The source of the stimulus and the point and mechanism of excitation for urinary peristalsis are not known absolutely but the visible contraction begins in the lesser calices about the apex of the pyramids. Neither is it known definitely whether the calices are excited independently at different time intervals or all are excited simultaneously by a single stimulus. Independent excitation at different times is illogical, for this would be at variance with the purposeful regularity of physiologic function, unless the stimulus to contraction is produced by the degree of distention of the calyx. One is not justified in assuming that, because demonstrable movement first occurs about the papillæ, this is the trigger point of excitation without adequate proof of such a statement. We believe that the contraction, regardless of origin, is a simultaneously excited unit wave proceeding from the point of excitation through the renal pelvis, and probably to the uretero-vesical orifice, where its purpose is completed. Contraction of the renal pelvis in all directions is easily demonstrable, and the apparent multiplicity of peristaltic waves is probably due to an absence of, and a difference in, the volume of fluid in the component parts of the kidney pelvis, and the smooth muscle adjusts itself to this volume at a given point, at a given time. Also, diastole and systole are not two entirely separate and distinct instantaneous phases, for refilling of the calices about the papillæ begins immediately behind the contraction. They cannot, therefore, be analogous to the diastolic and systolic heart cycles. Rarely is the normal ureter visualized completely, but it is visualized in segments, and there seems to be a relationship of this filling of the ureter to the activity of the renal pelvis. It is, therefore, probable that the demonstrable contraction visualized as beginning in the lesser calices continues as a unit through the pelvis and ureter to the bladder, and the apparent multiplicity is due to a rhythmic succession of contractions originating somewhere in the kidney.

[1] Presented before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11–15, 1939.

Regardless of the many theories as to the origin and action of peristaltic waves, that portion of the contraction which can be observed offers much for study. Peristaltic activity is influenced by healed lesions, chronic or acute diseases of the kidney and ureter, ureteral pain and irritants, bladder distention, obstruction from congenital and acquired causes, organic as well as non-organic lesions of the urinary tract, and by bladder and urethral conditions.

The urinary tract is essentially a closed system and must, therefore, have a normal physiologic equilibrium, which is probably changing constantly to meet present conditions. It would seem that a disease process would change this equilibrium. We believe the term "hydrostatics" applied to this phase is not amiss, and the variable types and degrees of disturbance of this equilibrium should have some importance in deciding whether or not normal renal function is present. This could result from urinary as well as extra-urinary pathology, and the point of disturbance often permits one to differentiate between intrinsic and extrinsic lesions.

The mutual complement of these factors to normal urinary function is so intimate that the factors cannot be separated into entirely distinct and separate phases. Emphasizing the small aberrations from normal will often permit one to detect lesions earlier, thereby allowing treatment at the most favorable stage and preventing permanent renal damage from infection, hydronephrosis, renal atrophy, etc. We should concentrate on the prevention of the advanced stages of renal pathology through early diagnosis by intravenous urography.

Transportation of the urine is a vital part of renal function and any condition which interferes with this must be considered as a cause for urinary symptoms, regardless of whether it arises in, or external to, the excretory system. We know that many urinary lesions manifest themselves by other than urinary symptoms, and it is plausible this is a reversible process, so that lesions entirely removed from the urinary tract may manifest themselves by urinary symptoms. Intravenous urography has emphasized that the urinary tract is not an isolated system which remains uninfluenced by general bodily states. It is our opinion that the sensitiveness of the urinary tract to conditions other than primary urinary pathology is too little appreciated.

Thus many factors make it a little difficult to interpret intravenous urography correctly, and, in order to be adept at it, one must first have a thorough knowledge of the probable, as well as the possible, causes for subjective and objective findings and must temper his conclusions with a basic knowledge of clinical medicine. No standard table of diagnostic criteria can be set forth for intravenous urographic diagnosis, since the same clinical entity is rarely manifested by exactly the same criteria.

Urinary Tract Obstruction.—Intrarenal, ureteral, and lower urinary tract obstructions cause rather definite types of organic and functional changes, depending on the type, duration, and location of the obstruction, and whether or not there is, or has been, an associated infection. The classification we have found which best meets our clinical need is: first acute, repeated acute, acute-on-chronic, and chronic obstruction. These acute stages are not always sharply differentiated but it is helpful to attempt interpretation on such a classification.

We do not consider the average case of ureteral calculosis to be always a case of complete ureteral obstruction. In those cases of partial obstruction which we have reason to believe have become completely obstructed, there has been no evidence of increasing density of the kidney shadow to indicate that filtration persists. These kidneys have always been large, either of organic increased or decreased density, depending on the duration of the obstruction or obstruction with infection. The absence of increasing dye density of the kidney means to us that there is suppression of function and that the case is an urgent one, demanding relief or most careful supervision.

The first acute partial ureteral obstruction, from whatever cause—more fre-

quently stones, many of which cannot be visualized on the plain roentgenogram—manifests itself by a gradually increasing density of the kidney without, or with slow, filling of the pelvis. This will be, in the majority of cases, the only evidence of renal function during the routine period of examination, but if a urogram is made in from one to several hours afterward, the pelvis and the ureter may be filled completely, with some decrease in renal density. Modified excretion will often occur if such patients are given morphine sulphate during the routine examination. This should not be considered as poor function but as acute partial ureteral obstruction with depressed renal function, although the location and the cause are not evident.

We do not know for certain where this dye accumulates. It has certainly left the blood stream and we can state with reasonable accuracy that filtration continues but excretion is impaired. There are several probable causes. We consider the increasing density of the renal shadow to be due to the collection of the dye in the tubules as a result of depressed filtration from increased intrarenal pressure, which approximates but does not equal glomerular pressure. Reflex depression from pain must also be considered, for the obstructed kidney will often resume modified excretion when pain is the only known symptom which has been relieved. This fails to explain the phenomenon completely and some unknown factors are yet to be determined. We must consider the possibility that the dye fails to reach the renal pelvis because, in the presence of ureteral obstruction, a readjusted physiologic process occurs which permits reabsorption of the dye from the tubules.

Bladder distention might also cause a reflex depression. We have had one case in which the bladder was left distended during cystoscopy. The right ureter was obstructed to the catheter. The left ureter was catheterized and a retrograde pyelogram showed a normal left kidney. Intravenous urography was decided upon to determine the condition of the right kidney and the cause of the obstructed right ureter. The patient complained bitterly of pain during preparation for this examination which immediately followed cystoscopy. The distended bladder was recognized on the five-minute urogram. At this time the left kidney pelvis had an almost identical appearance as of the retrograde pyelogram, and the response of this kidney was that observed in acute partial ureteral obstruction. The bladder was catheterized and a urogram was made immediately upon withdrawal of the bladder catheter. The left kidney emptied at once, the increased density disappeared, and it continued to excrete normally during the remainder of the examination. The kidney of the obstructed ureter had the characteristic response to an acute-on-chronic ureteral obstruction, and this was not influenced by bladder catheterization. There must be some explanation for this different response to bladder distention and catheterization. Conclusions cannot be drawn from a single case, but this one does indicate that there is depression of function from bladder distention, either from increased pressure or reflex (in origin), the disturbance being chiefly in the excretory mechanism. This suggests that one should guard against periods of acute distention of the bladder in order to avoid possible organic damage to the kidneys, and in the presence of abnormality of transportation of urine one must keep in mind the possibility of a distended bladder as a cause of the disturbance.

The repeated acute ureteral obstruction causes much the same appearance as the acute first obstruction, but there are usually some signs which indicate that the case is one of repeated attacks. The increasing density of the kidney progresses more slowly and is usually less than in first acute obstruction, and the transportation of urine is better maintained. The pelvis often fills and is usually larger, the apices of the pyramids are more flattened, peristalsis is present but diminished, and occasionally the ureter will fill quickly, to the point of partial obstruction. It seems that the kid-

ney adjusts itself to these repeated attacks by excretory compensation.

In repeated acute exacerbations on chronic ureteral obstruction, there is usually an immediate but less progressive increase in renal density, associated with a hydronephrosis, and there is an adynamic type of transportation of the fluid medium to the bladder. The ureters become distended to the point of obstruction. In the occasional case of bilateral chronic ureteral obstruction, all media will be collected in dilated ureters and pelves over a period of one hour or more. The more acutely obstructed kidney can usually be recognized by a more rapidly increasing density of the kidney, slower filling of the kidney pelvis and ureters, and less dilatation of the ureter. It appears that the kidney which has been functioning against the obstruction of longest duration will sometimes, under added stress because of obstruction of the opposite kidney, assume added function, of which it is incapable when the opposite kidney is not acutely involved.

Chronic ureteral obstruction without the acute factor manifests itself by an early stasis about the papillæ, which is associated with absent to markedly diminished peristaltic activity, slow progressive and sustained stasis in the pelvis, no evidence of increase in the kidney density, and a dilated ureter to the point of obstruction—and sometimes beyond. One can usually determine when an acute factor has been superimposed in these cases by the size, shape, and organic density of the kidney itself, and by the delay of excretion as indicated by the collection of dye in the tubules.

Ureteropelvic juncture obstructions are due most frequently to external causes, such as faulty position or rotation of the kidney, deep hïla with dense peripelvic tissue, fascial bands, and anomalous blood vessels. These lesions are detected early by the disturbed renal peristalsis, manifested first by inactivity and stasis in the lesser calices and not by a sacculated dilatation of the renal pelvis. There is no evidence of the kidney shadow increasing in density to indicate an acute factor in the usual case, but this might be observed if we could examine these patients during periods of discomfort. Sensitive points of fixation and angulation of the ureteropelvic juncture are often detected, later to be ironed out by distention of the pelvis incident to retrograde pyelography. Apparently the kidney can compensate against this group of obstructions for a much longer period without developing infection than it can with a similar degree of obstruction in the lower ureter. The non-visible phase of renal function, as determined by the various functional dye tests, may be adequate, and dependence on these tests will often cause one to overlook the disturbance in the transportation of urine, thus preventing early recognition and correction of such a condition. In our experience, patients of this type are often neglected, mistreated, or overtreated. It is also difficult to get such patients to consult a urologist unless the hydronephrosis is recognizable on sight, by which time considerable damage will have occurred. Intravenous urography is far more valuable in a group of individuals of this type than retrograde pyelography, particularly in the early stages of obstruction.

Ptosis.—In cases of suspected ptosis we have been doing a few of our intravenous urograms in the upright position after obtaining a control urogram in the supine position. These kidneys do not seem to excrete the dye as well in the erect as in the supine position. We have observed a few interesting points in one case. In the supine position there was no evidence of abnormality of filtration or excretion but when the patient stood erect the kidney dropped and there was considerable rotation on its longitudinal and vertical axes. This kidney pelvis was not visualized completely in the erect as in the supine position and although the individual was kept on her feet, there was a complete disappearance of the medium from the kidney pelvis and ureter, while the non-rotated left kidney continued to function. There was no increase in the density of the kidney to indicate that the medium was leaving the blood

stream, and one must assume that the dye was not passing through the glomeruli; that is, the kidney was organically normal but in the erect position there occurred an ischemic suppression of function, probably from rotation on the renal pedicle, which permitted sufficient blood for nourishment of the normal kidney tissue but was insufficient in amount, or pressure, to carry on normal filtration. This seems to be the only logical assumption, for, if there were complete loss of circulation in the erect posture, the kidney would soon be damaged, and if there were persistent function in this ptosed position, with obstruction from this position, there should be some evidence of abnormal transportation of the urine from the pelvis to the ureter. It follows that in suspected cases of ptosis of the kidney or in cases presenting vague kidney symptoms in which the intravenous urogram appears normal in the supine position, it would be advisable to examine the patient in the erect posture. The possibility of ischemic suppression must be considered seriously. We are not yet ready to make a positive statement concerning this observation. We do think, however, that one should emphasize the type and degree of rotation as well as the vertical position of the kidney in these cases and attempt to evaluate function on the basis of both conditions.

Time does not permit a consideration of other phases of intravenous urographic diagnosis. The above lesions form, and contribute to, a large volume of urinary-tract disease, the type which probably presents the most bizarre symptoms in a group of patients frequently neglected, mistreated, overtreated, or inadequately treated. We do not wish to leave the impression that sharp differentiation of degrees of obstruction of acute nature can always be made, but we do stress the need of attempting to do so. This promotes keener observation, and clear thinking toward the solution of, and the importance of, some rather interesting phenomena observed clinically and not explained by standard textbooks. These phenomena probably cannot be produced at will in experimental animals, and their evaluation must be attempted through the medium of visible urinary function by intravenous urography in the human.

ROENTGEN VISUALIZATION OF SOME OF THE COMMONER LESIONS OF THE LOWER GENITO-URINARY TRACT[1]

By L. E. SORRELL, M.D., *Birmingham, Alabama*

SINCE the discovery of the x-rays by Roentgen, radiologists have been using them as a diagnostic aid in many diseases. In modern medicine the roentgen ray is almost indispensable in the diagnosis of lesions of the genito-urinary tract.

This paper will be confined to some of the lesions of the lower genito-urinary tract, which we hope to show by the use of contrast medium. This paper is not written with the thought of showing any new diagnostic procedures or disease, but merely as a review of some of the lesions of the lower genito-urinary tract.

Case 1. Dermoid. Colored female, aged 21 years. This patient was seen in April, 1938, complaining of frequency and burning on urination and pain in the lower left quadrant. There was some hematuria. On cystoscopic examination there was seen evidence of cystitis, and the bladder capacity was only 90 c.c. of urine. There was a tumor mass about the left ureteral orifice from which hair appeared to be growing. From an air cystogram there appeared an irregular, fuzzy mass filling about one-half of the bladder. Radiologic diagnosis was tumor of the upper left quadrant of the bladder; diagnosis undetermined. Surgical removal revealed a dermoid tumor. Several weeks later an air cystogram revealed an apparently normal bladder.

Case 2. Seminal vesiculitis. E. C. C., white male, aged 44 years. He had been seen eight years previously, at that time with a gastro-intestinal complaint of which he apparently had been cured. Two years before the present admission he returned with low back pain and headache.

Radiologic examination of the lower spine revealed arthritis of slight degree. Radiologic examination of the sinuses revealed them to be cloudy in the first degree. He had had considerable treatment by several ear, nose, and throat men, without much relief. He was later referred to the genito-urinary department. The prostate showed some pus and was treated without much relief. Injections of the seminal vesicles with sodium iodide showed the right side to be apparently normal, while the left was slightly fuzzy, which, we think, is diagnostic of chronic inflammation. We treated his sinuses and seminal vesicles with roentgen therapy and he states that he has had complete relief.

Case 3. Diverticulum of urethra. Colored female, aged 41 years. She was seen in December, 1937, complaining of pain in the vagina of several months' duration, more marked on urination and during intercourses.

Past history was essentially negative except for removal of two calculi several years previously. Examination revealed a mass about 2 centimeters in diameter in the anterior vaginal wall over the urethra, tender, with redness and swelling.

On cystoscopic examination an opening between the meatus and bladder was seen, which admitted a catheter—it could be coiled inside of the opening several times. Opaque material was injected in this catheter and a diverticulum about two centimeters in diameter was visualized. The lesion was removed surgically and the patient has had no further symptoms.

Case 4. Prostatic calculi. J. S. W., aged 61 years. His chief complaints were dysuria and frequency of several years' duration. He gave a history of passing small stones over a period of years. There was soreness and pain in the perineum; the prostate was stony hard and nodular, and considerable pus was found on massage.

[1] Presented before the Twenty-fifth Annual Meeting of the Radiological Society of North America, at Atlanta, Dec. 11–15, 1939.

Radiologic examination of the bladder and prostate revealed numerous discrete areas of increased density, from 1 mm. to 1 cm. in diameter, which were diagnosed as prostatic calculi. In view of the fact that this man was a diabetic and was having no serious trouble with this condition, no operative procedure was done.

Case 5. Enlarged prostate. N. B. A., white male, aged 66 years. This patient was admitted to the hospital Oct. 4, 1939, complaining of frequency and dysuria of several years' duration. He had been treated for prostatitis for several years and had worn an indwelling catheter with some improvement. The patient had 1,000 c.c. of residual urine in the bladder. The prostate was enlarged to the fourth degree on rectal examination. A hard rubber catheter was passed into the bladder through the urethra and the bladder was filled with air. The roentgen film revealed a mass filling about one-half of the bladder volume, which was considered to be the prostate. The patient has been resected since, with good results.

Case 6. Bladder diverticulum. E. M., aged 58 years. This patient's chief complaints were frequency and dysuria, and he stated that these had increased for about three years. He had had nocturia ten to fifteen times each night, voided every thirty minutes during the day, and about one ounce each time. He had two or three ounces of foul residual urine. He at no time had hematuria or calculi. The man had lost 60 pounds in weight in five years and had grown progressively weaker.

Radiologic examination of the bladder revealed a sac connected with the bladder, about the size of a dilated bladder. A diagnosis of diverticulum was made, which was confirmed by operation. The patient had an uneventful recovery and at present is enjoying normal habits.

Case 7. Bladder calculus. F. M., white male, aged 34 years. His chief complaints had been frequency and dysuria for six years. For the past several months, he had had some complicating hemorrhage. He had voided every fifteen minutes during the day and had to get up ten or fifteen times every night. His bladder capacity was one ounce.

When a cystoscope was passed into the bladder, a definite click was felt and a calculus was suspected. A mass thought to be a stone was seen hanging from the dome of the bladder. Radiologic examination revealed a dense shadow which was diagnosed as a calculus. Operation confirmed the diagnosis and the patient had an uneventful recovery.

Case 8. Carcinoma of the bladder. C. P., aged 21 years. His chief complaints were frequency and dysuria of eighteen months' duration. He had hematuria for several months, which had been increasing with each attack. He had lost considerable weight in the past few weeks and was markedly emaciated.

A film made of his bladder revealed an irregular, fuzzy mass which was diagnosed as some type of rapidly growing tumor, probably carcinoma. Surgical intervention confirmed this diagnosis.

Case 9. Bilateral ureteral regurgitation. Colored male, aged 34 years. This patient's complaints were frequency and dysuria, increasing for several years. He voided approximately every hour, had foul urine, and passed calcareous deposits. He had lost considerable weight in the past several months, and had been running temperature of from one to two degrees for several months.

Radiologic examination revealed a large bladder, dilated tortuous ureters with the opaque fluid extending into the pelvis of each kidney. A diagnosis of bilateral ureteral regurgitation was made. The prognosis is always poor in this condition, and the patient died one month later from sepsis and renal insufficiency.

CONCLUSIONS

1. Nine cases have been presented with pathologic lesions of the lower genito-urinary tract.

2. With intravenous pyelography, opaque medium or air injected into the bladder, it is possible to make a diagnosis

in a high percentage of the pathologic conditions of the lower genito-urinary tract without cystoscopic examination.

DISCUSSION

J. ANDREW BOWEN, M.D. (Louisville, Ky.): There are several things in Dr. Shiflett's and Dr. Sorrell's papers in defense of intravenous urography which especially appeal to me as a urologist, and I gratefully take this opportunity of adding a few of my opinions in this regard.

As you all know, in the field of urology, cystoscopy and x-ray examination long have been associated, the first being considered incomplete without the second when the upper urinary tract was under investigation. It is well within the memory of most of you when, in the case of stone in the urinary tract, a plain kidney-ureter-bladder plate was held sufficient by a great number of surgeons, only the most careful of whom fell back upon a functional test of one type or another before undertaking surgery.

The clinical application of any diagnostic procedure should be undertaken always with the following question in mind: How and to what extent are we changing existing conditions by our procedure?

The taking of x-ray films in no way affects physiology or morphology but this most certainly is not true of cystoscopy. Even when done by the most skillful operator and under the best of conditions, marked reactions occasionally occur, and I am sure that in every case there is some little alteration in the physiology of the upper urinary tract.

As usually done, after the scope is passed the bladder is distended to the point where contractions begin, or, as we say, a desire to void is obtained. More often actual pain is caused. Catheters are then passed more or less readily up to the kidneys and, in so doing, it is not unusual for the cystoscopist to be able to differentiate readily increases in the tone of the ureters, which are often accompanied by pain.

By their nature catheters undoubtedly obscure certain small aberrations from normal, such as strictures, areas of increased or decreased peristalsis, etc. Many of you will also agree that the proper distention of the pelves for the purpose of the retrograde pyelogram is still somewhat of an art.

It became apparent certainly as long ago as 1921 (Goldstein) that the passage of catheters might act at times as a detriment to the proper interpretation of the pyelogram, hence the delayed urogram was suggested. This does not rid us entirely of the objection because cystoscopy must still be done and the catheter passed, but it does help to some extent because the injected fluid is more viscid and is deliberately left behind after the catheter is removed. This was a great help in the establishment of conditions as they existed to cause the symptoms found, whether the outflow of the medium was seen under the fluoroscope or on permanent plates.

Renal function, too, has long been considered as an important part of cystoscopic examination of the upper urinary tract, especially when surgery of one of the kidneys was to be undertaken. Under ordinary conditions, when we find a function within or above normal limits on the supposedly good side, we accept this without question, but should this function not be good it does not necessarily follow that the kidney is not normal, because the passage of the catheter alone may be sufficient irritation to affect secretion. We then must accept the retention products in the blood as an indication of function, or repeat the examination.

In the majority of cases in which the disease is of gross extent, these objections do not hold, and a carefully done cystoscopic examination with retrograde pyelograms and divided functional tests will provide all the information necessary to arrive at a diagnosis and a basis for outline of treatment.

But intravenous urography, when properly done, supplies most of these facts and others in addition, *i.e.*, it more readily maintains the *status quo* of existing conditions; it affords a functional test of the

kidneys, divided and combined; it provides an indication of the dynamic activity of the excreting portion of the upper urinary tract, and it permits the observation of small variations in the size of the ureteral lumen often obscured by the passage of catheters.

In short, intravenous urography gives us a physiologic as well as a morphologic basis for diagnosis. This fact is definitely brought out by Dr. Shiflett in his discussion upon the alterations found—physiologic and morphologic—in repeated attacks upon the pelves and ureters by recurrent obstruction to the free outflow of urine.

Since the kidney contains no muscular fibers, the term "dynamics," *i.e.*, the propulsion of urine downward by means of rhythmic muscular contractions, must be limited to those structures of the urinary tract endowed with muscle fibers, here the calices, pelves, and ureters. The filtration of the urine in no way affects the peristaltic activity of the pelves and ureters except possibly by initiating the action through weight volume delivered or by affecting the rate of contractions by marked increase or decrease in the volume delivered.

But the effect upon secretion is often marked by interference with peristalsis, as so well illustrated by Dr. Shiflett, by the progressive increase in density of the kidney substance in his cases of small ureteral stones. This effect is so great that if the intrapelvic pressure reaches a point of from 50 to 60 mm. of mercury below that of the systolic blood pressure, filtration ceases entirely.

In retrograde pyelograms we must lose this physiologic change. Between the points, then, of normal peristalsis and complete cessation of filtration due to increased intrapelvic pressure, lies a broad field of altered physiology shown more or less readily by changes in rate and force of peristalsis and by dilatation of ureter and pelvis.

I do not believe it has been Dr. Shiflett's desire to criticize or limit cystoscopy, but I do think he has shown by intravenous urography that in certain lesions in which there has been no great change in morphology the lesser physiologic changes in the passage of urine from the calices to the bladder may be seen and, when taken with a proper consideration of the clinical symptoms, will guide us earlier along a proper course of treatment.

As Dr. Sorrell has pointed out, x-ray examination is not quite so important in diagnosing lesions of the lower urinary tract. These can be diagnosed accurately by cystoscopic examination, and x-ray examination is of value chiefly in a confirmatory rôle. Of course, when it is possible to get the pathologic area under direct vision, the accuracy of diagnosis should be limited only by the experience of the observer.

However, in many cases instrumentation may not be advisable for various reasons, so that the examination can more safely be left entirely to the roentgenologist. This fact is particularly true in Dr. Sorrell's last case of extreme degree of urinary infection, with regurgitation. This situation exists most often in bilateral renal tuberculosis (however, in this instance I do not think this is a case of bilateral renal tuberculosis but rather a complete distention due to some congenital or possibly acquired obstruction at the bladder neck), in which I believe a cystogram is decidedly less harmful than the more extensive cystoscopic examination which usually demands a spinal, sacral, or even a general anesthetic. In the event the examination giving the lesser chance for reaction fails, the instrumentation can always be done, but many times this can be avoided, as has been so clearly shown.

In short, I believe, personally, that we are not obtaining all possible information from intravenous injections for the purpose of pyelograms. It has been a source of great comfort to me in some of my cases, especially those in infants or children, to feel that I can resort to the injection method and rely upon the roentgenologist to determine whether or not a cystoscopic examination should be done for further confirmation.

BERNARD H. NICHOLS, M.D. (Cleveland, Ohio): It gives me great pleasure to discuss Dr. Sorrell's paper in which he has brought out many interesting points; however, I would like to comment on the diverticula of the bladder. In most instances I think these diverticula may be visualized by cystoscopy. However, they are often missed by this procedure alone, but, if they are viewed, it is always possible to determine their size or possibly the presence of stones. We feel, therefore, that a cystogram made with opaque medium in the bladder, followed by roentgen examination in the postero-anterior position or in the anteroposterior position and a direct lateral film, will give a very good idea of the size, position, and the opening from the bladder into the diverticulum. The lateral view is quite essential because many times the diverticulum is directly on the posterior wall of the bladder and may be missed unless a lateral film is taken. The presence of retention in a diverticulum is of great importance in determining the possibility for production of symptoms. Therefore, the patient should be instructed to void or the bladder should be emptied by a catheter and the final examination made to determine the presence or absence of retention.

Air cystograms may also be used for the visualization of stones or other pathologic lesions in the bladder. The making of seminal vesiculograms is an art in itself, which requires special instruments and skill in the catheterization of the seminal vesicles. Such an examination, however, is oftentimes of very great value, particularly in the determination of the presence of a tuberculous infection in the seminal vesicles. Also other types of pathology in these vessels may be diagnosed by this procedure.

I also want to compliment Dr. Shiflett and I think the Society owes him a debt of gratitude for the contribution which he has brought before us. This has required a great amount of detailed work in order to demonstrate the possibility of determining function and filtration in the kidney and the evaluation of these findings on our excretory urograms. This also, I think, emphasizes greatly the importance of doing excretory urography in a routine systematic manner in all cases, without attempting in any way to interfere with the function of the dynamics of the urinary tract (such as dehydration and obstruction of the ureters) even to the point of requiring the patient to prevent emptying the bladder during such an examination. If the bladder is distended and the patient has a desire to urinate, the bladder should be emptied, as over-distention may interfere with the dynamics of the ureter. In cases of lesions of the bladder it is always easy to do a cystogram if roentgen visualization of the bladder is desired by the pathologist. I should also like to agree heartily with Dr. Shiflett in the statement that extrarenal lesions may readily influence the function of the kidney and that the presence of a dense kidney on an excretory urogram may indicate quite readily the inability of such a kidney to excrete its filtration contents.

E. L. SHIFLETT, M.D. (*closing*): I do not wish to leave the impression of a lack of appreciation for cystoscopy and retrograde pyelography. Quite often, after studying the primary roentgenogram we advise cystoscopy and retrograde pyelography because we do not believe the condition can be adequately studied by intravenous urography.

My plea is for more frequent use of intravenous urography to detect early those abnormalities in the vital function of the transportation of urine and thus prevent prolonged morbidity, pyonephroses, late nephrectomies, and unnecessary surgical procedures because of misleading subjective complaints. I believe that a high percentage of urinary infections and hydronephroses have as a predisposing factor some minor disturbance in excretion, and that, by intravenous urography, we can detect such abnormalities earlier, thus preventing these sequelæ.

POST-RENAL ANURIA FOLLOWING ROENTGEN THERAPY FOR PELVIC TUMORS[1]

By GEORGE W. CHAMBERLIN, M.D., FRANKLIN L. PAYNE, M.D., *and* LLOYD W. STEVENS, M.D., *Philadelphia*

From the Departments of Radiology and Gynecology of the Hospital of the University of Pennsylvania

ANURIA, due to obstruction of both ureters, is a rare complication during roentgen therapy of tumors within the pelvis. Still more rare is the occurrence of two bilateral symmetrical tumors, each involving the lower end of a ureter. We have been unable to find any other such case in the literature.

The term "post-renal" is used to indicate the source of the anuria distal to the kidneys. This type of anuria, when not due to ureteral calculi, is most frequently associated with tumors of pelvic structures, particularly tumors of the bladder or uterus. In most cases which have been reported in the literature, involvement of the ureters is a late effect of irradiation or of tumor extension. Instances of carcinomatous obstruction of both ureters with anuria have been reported by Myers (7), Howe (5), Roberts (9), and others. Farlow (4) cited one instance in which a pelvic tumor which was not connected with the uterus, vagina, bladder, or rectum produced anuria for 12 days. He does not state the exact nature of this tumor. Myers (7), in 1925, reviewed the literature and added one personal case in which recurrent uterine carcinoma resulted in anuria.

There is a dearth of literature dealing with anuria produced by tissue edema following irradiation therapy. Bugbee (1) has reported eight and Exley (3) two instances of ureteral obstruction following radium therapy for carcinoma of the uterus. All of these, however, may be classified as late effects caused either by continued growth of the tumor, such as Drexler (2) and Howe (5) have found, or by fibrosis and constriction due to irradiation therapy as Bugbee (1) has indicated. Maintz (6) has cited four instances in which anuria occurred as a complication of roentgen therapy early in the course of treatment for carcinoma of the uterus. His patients remained anuric as long as five days. He attributed the cessation of urinary excretion to swelling of the ureteral mucosa. In some respects his cases were similar to the following one.

C. M., a colored female, 27 years of age, with a history of lower back pain and paresthesia of the legs, was found to have two inoperable pelvic tumors not connected with the uterus or other pelvic viscera. Anuria resulted eight days after the first roentgen treatment, lasted eight days, and was followed by a return of minimal amounts of urinary secretion for two days before death.

The patient was admitted to the service of Floyd E. Keene, M.D., at the Hospital of the University of Pennsylvania, on May 18, 1938. One month prior to admission, she began to complain of numbness in both thighs which was followed shortly thereafter by constant pain in the back and in both thighs, which gradually became excruciatingly severe. For six months previous to admission she had had a poor appetite and had lost 22 per cent of her body weight.

Physical examination revealed a fairly robust young colored woman who insisted upon lying on one side with her thighs partially flexed and complained bitterly when they were straightened. The examination of the thorax and abdomen revealed no notable abnormalities. Vaginal and rectal examinations disclosed bilateral, tender, solid pelvic masses, the larger on the right. Both were firmly fixed to the lateral walls of the pelvis. Roentgen examination of the pelvis and lumbar spine showed no osseous involvement.

[1] Accepted for publication in March, 1939.

Chest roentgenograms were negative. Laboratory studies made on May 19, 1938, were as follows: red blood cells, 3,260,000; hemoglobin, 57 per cent; white blood cells, 8,200. The urine studies showed nothing abnormal. Blood urea nitrogen was 10 mg. per cent. The sedimentation rate was rapid. Kolmer and Kahn tests were negative. On May 24, 1938, an exploratory laparotomy, done by one of us (F. L. P.), showed the uterus, tubes, and ovaries to be normal. Situated within the broad ligaments on either side there were stony-hard, pyramid-shaped masses with their apices pointing to the uterus and their bases firmly fixed to the lateral pelvic walls. The masses did not reach the lateral borders of the uterus, nor did they meet each other posterior to the uterus. A diagnosis of retroperitoneal cancer was made but a biopsy was not attempted because of the danger of hemorrhage. Following the operation, a urographic examination was considered but it was decided to postpone this and proceed with the roentgen treatment in an attempt to relieve the extremely severe pain which made it almost impossible to place the patient in the supine position for a urographic study without exaggerating her symptoms. Accordingly, on June 2, 1938, irradiation was started by using two posterior and one right anterior pelvic portals. The physical factors used were 200 kv., 20 ma., 50 cm. S.T.D., 0.5 mm. copper plus 1 mm. aluminum filter. The half value layer with this arrangement is 1.06 mm. copper. The daily dose varied from 99 r at the first treatment to 220 r. The total dose, as measured in air, was 418 r × 3, delivered June 2 to June 10, inclusive. Following this amount of irradiation, there was an increase in the size of the pelvic masses as determined by vaginal and rectal examination. On June 10, the patient became anuric and blood urea nitrogen rose to 96 mg. per cent. The following day plasma CO_2 was 37 volumes per cent and chlorides 83.5 milli-equivalents per liter. Anuria continued from June 10 to June 17, during which time the appearance of the patient was unusually good. She was quiet, composed, and mentally alert. On June 18, however, she became irrational and later comatose. The blood urea nitrogen at this time was 125 mg. per cent. The advisability of bilateral ureteral catheterization was discussed at this time, but was not attempted because of the hopelessness of the prognosis. Small amounts of urine were passed on June 19 and 20, but the patient failed to regain consciousness and died on June 21, 1938.

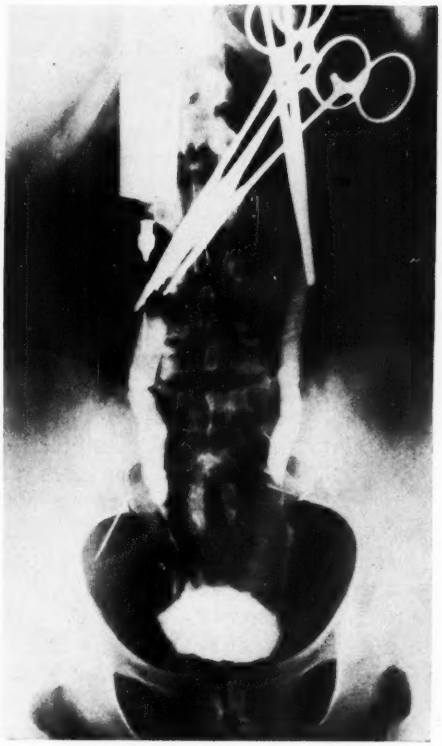

Fig. 1. Roentgenogram made postmortem after injection of sodium iodide into proximal ureters. The straight pins are placed along the iliac vessels. The lower three inches of the ureters are narrowed and displaced somewhat medially. The proximal ureters are dilated.

Postmortem Examination.—The important gross findings were as follows: There was an obvious hydronephrosis involving both kidneys with both ureters dilated with clear urine and narrowed as they dis-

appeared over the pelvic brim beyond the point where the iliac vessels crossed. Here they passed through dense fibrous tissue which bound them to the tumor masses on either side of the pelvis. The latter masses were composed of dense, white, firm, avascular tissue which lined both posterolateral pelvic walls but did not connect across the midline. They were apparently two separate, symmetrically located newgrowths which did not arise from the bony structures of the pelvis. No enlargement of the regional nodes was demonstrable. The stenosis of the ureters was demonstrated by injecting sodium iodide solution into the upper ureters and exposing a film at the autopsy table (Fig. 1). The bladder was not involved in the process. The only other positive finding of interest was that of a solitary benign intramural myoma measuring 1.5 in. in diameter. Grossly, the kidneys showed only the changes characteristic of cloudy swelling. There was no evidence of metastasis.

Histologic Study.—Sections of the tumor show long and short strands containing cells of irregular size, shape, and staining qualities in diffuse distribution through the tissue, extensively invading voluntary muscle. Some cells are circular in shape, with huge pyknotic nuclei, little cytoplasm; some are syncytial, deep-staining bands, while others consist almost entirely of large masses of pale pink, hyalin-like cytoplasm. In addition, there are short, blunt, deep-staining rods, frail spindles, and cells with round vesicular nuclei in which mitotic figures can be seen. Separating the cellular elements is a stroma of fibrous tissue. The whole presents a most irregular picture. On consultation, it was decided that the growth was probably an immature tumor of neurogenic origin, but that a more definite classification was impossible (Figs. 2 and 3).

Comment.—A survey of the literature indicates that anuria of eight days' duration is not, in itself, unusual. Many patients have been known to survive 30 days and some for even longer periods. Parr (8), in 1819, described a patient who was anuric for six weeks and eventually recovered. The clinical appearance of

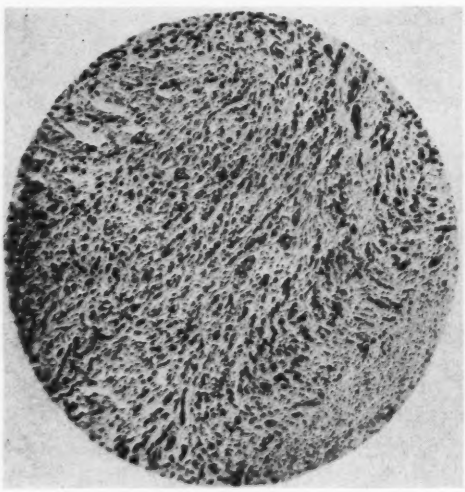

Fig. 2.

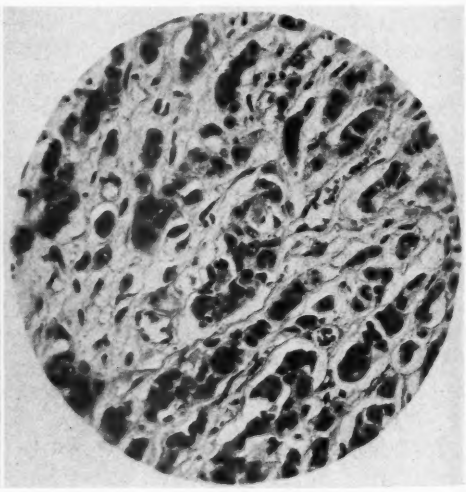

Fig. 3.

Fig. 2. Low power magnification to show the general arrangement of the long and short strands of cells (× 57).

Fig. 3. Note the strands containing cells of irregular size, shape, and staining qualities. Some cells are large with pyknotic nuclei, some are syncytial, and others consist of masses of pale pink, hyalin-like cytoplasm (× 230).

our patient was different from that usually seen in individuals who develop anuria as a result of chronic renal disease. It is evident that the body can maintain itself uncommonly well in spite of the retention of urinary secretion. Wharton Sinkler (10), in 1896, wrote:

"It would seem at first thought that complete anuria would inevitably be followed within a day or two by decided uremic symptoms. This, however, is not the case, except in those instances in which diseased kidneys have gradually been excreting less and less urine, so that urea and other excrementitious products have been steadily accumulating in the economy."

There seems to be little doubt that irradiation produced sufficient edema in the tumor to cause a complete bilateral ureteral obstruction. This swelling was evident by rectal and vaginal examinations and also by the fact that the urinary secretion returned several days after roentgen therapy was stopped. In retrospect, it is evident that intravenous urography for the purpose of studying the exact condition of the urinary tract was indicated before roentgen therapy. Furthermore, it must be constantly borne in mind that relatively small doses of irradiation to such tumors may produce local swelling sufficient to obstruct the ureters when the margin of safety has already been reduced.

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BLOCKING OF THE URETERS IN INTRAVENOUS PYELOGRAPHY BY MEANS OF FILLING THE BLADDER WITH OIL[1]

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AS THE main causes of misinterpretation of pyelograms, Wesson and Ruggles mention the following: (1) Incompletely filled kidney pelvis; (2) spasm of pelvis and ureter; (3) unilateral film without showing a congenitally deformed pelvis and no information as to whether or not the opposite side is similar; (4) splinting effects of ureteral catheters, straightening kinks and angulations, and (5) improper position of ureteral catheters.

The last three causes are avoided in intravenous urography while the first two conditions mentioned are somewhat increased by this method. The film obtained by the intravenous method is frequently inferior to that of the retrograde because in the former there is often an incomplete filling of the pelvis and ureter. The contrast material may be prematurely eliminated and the bladder often filled with dye a few minutes after injection, thereby obscuring the lower part of the ureters completely.

Such films may present insufficient and misleading information. Frequent attempts have been made, therefore, to block the dye elimination and thus to effect more complete visualization of the pelves, calices, and ureters. Such a visualization has been obtained by placing the patient in the Trendelenburg position, although it is difficult to understand how an empty bladder with no intravesical pressure could resist the powerful peristalsis of the pelvis and ureter.

Another method of blocking the ureters is by insertion of a ureteral catheter, but it is the very purpose of intravenous urography to avoid instrumentation. Perhaps the most widely used method is compression of the ureters against the spine or upper sacrum by various ball-shaped devices. In thin individuals, such devices more or less suffice to exert the necessary pressure over the ureters to produce compression and stasis. However, such pressure may induce further spasm which is recorded as a shadow defect on the film, and, in addition, it may displace or distort the ureter. In obese patients these devices are difficult to keep in place, yet this is essential throughout the examination. It is especially difficult to apply this method in a patient who is having colicky pain or some other abdominal pathology. Furthermore, in patients with low-lying or congenitally ectopic kidneys, abdominal pressure may defeat the very purpose for which it is intended.

Another and decidedly better method of blocking the ureters would be the use of a drug which could contract the intramural portion of the ureter only, but such a drug is not yet known. All drugs causing contraction also increase the tonus of the pelvis and ureter and may be dangerous in the presence of stones.

We are herewith presenting a simple method, apparently yet untried, which consists of filling the bladder with oil, of greater or lesser specific gravity. Our first intention was to fill the bladder with concentrated sodium iodide solution which would sufficiently cover the trigone and ureteral orifices, thus keeping back the dye in the ureter by its counter-weight, but this would mean an additional burden of iodine in the organism.

We preferred to try a light, inexpensive oil, definitely harmless (mineral oil). When

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the patient lies flat on the Bucky table, the trigone is well covered even if the bladder is not completely filled. However, it is of advantage to empty the bladder as completely as possible and then fill it to capacity with oil. The intravesical tension retards the outflow of the dye from the ureters. Using this method in a limited number of cases thus far, we have found complete filling of the pelvis and calices without any misleading dilatation. The ureter was more completely visualized and was less subject to spastic contractions.

Another advantage of this method is the better visualization of the lower part of the ureters. Here disease is often located but usually obscured by the bladder when it is filled with contrast material. The method we are presenting eliminates this difficulty because the density of oil is considerably less than that of the muscle and soft-tissue structures. Therefore, the pelvic region and lower ureters are more easily penetrated by x-ray and appear unusually clear. A fine irregular line visualized in the pelvic aperture is usually caused by some dye which escaped under pressure and is accumulated between the oil and the bladder wall. Thus we have an outline of the bladder. The films taken 35 and 40 minutes after injection of the dye usually show more contrast material within the bladder, giving additional cystograms which, however, appear later and are less dense than with the usual procedure.

Fig. 1.

Fig. 2.

Fig. 1. Bladder filled with oil. Dye kept well back in ureter. Note lower ureteral end visualized through oil filling.

Fig. 2. Bladder filled with oil. While some dye escaped, there is sufficient retention of the dye to outline completely the calices, pelvis, and ureter without compression.

The technic of filling the bladder with oil is simple: it consists of cleansing the urethral orifice, inserting an ordinary rubber catheter, emptying the urine, and injecting mineral oil by means of a bulb syringe or by gravity method. Stop injecting when the patient complains of pressure. The patient voids the oil after the films are taken.

Contra-indications include all conditions in which catheterization of the bladder

would be contra-indicated. This applies particularly to severe urethritis, severe infections of the bladder, and old prostatics with chronic residual urine. One must also keep in mind the theoretic possibility of oil embolism. Therefore, one should avoid using the method in advanced lesions of the bladder and in all cases of bleeding from the bladder. Excessive pressure in injecting the oil should be avoided.

Fig. 3.

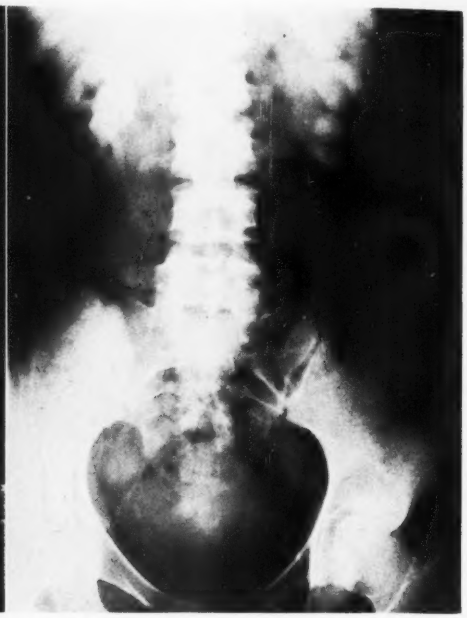

Fig. 4.

Fig. 3. Unfavorable conditions: Gaseous bowel distention. Calices, pelves, and ureters well visualized by means of filling the bladder with oil.

Fig. 4. Hydronephrosis, left side. Right side visualization of distended pelvis, calices, and ureter by means of filling the bladder with oil.

The following simple experiment was performed to demonstrate the principle involved in this method. We filled a small container with oil, placed the tip of a catheter at the bottom and with a syringe slowly injected water or urine colored with eosin. We found that a considerable pressure was necessary to inject the urine—a pressure proportionate to the mass of oil which has to be raised. The coherence and surface tension of the oil is sufficient to block the ureteral orifices and to overcome the normal peristaltic force of the ureters, without even considering the tonus of the bladder. In addition, there is a contraction of the bladder musculature because of the intravesical tension closing the ureteral orifices, thus preventing reflux.

SUMMARY

By filling the bladder with from 150 to 250 c.c. of oil, we are able to prevent the intravenous dye from reaching the bladder, thus keeping it back in the ureters and pelves without further need of any outside compression. We thus have:

1. A more complete filling of pelves and calices.
2. Less spastic and reflex contractions of pelves and ureters than with other methods.
3. A clear outline of the lower pelvic portion of the ureters which is usually obscured by the presence of dye in the bladder.

The procedure is simple and harmless when contra-indications are observed.

CASE REPORTS AND NEW DEVICES

TRAUMATIC PERIOSTITIS AND MALACIA OF THE FOOT[1]

By LEO HYMOVICH, M.D., *and* ARNOLD L. BACHMAN, M.D., *Stamford, Connecticut*

Traumatic periostitis and malacia of the foot is a condition closely akin to "march foot." We report such a case because we believe it is a rare variant of the latter disease and, as such, may be of value in an understanding of the pathogenesis concerned.

It is generally accepted that "march foot" results from excessive strain and fatigue of the feet (6, 9, 11). The condition is most often encountered among infantry soldiers and that group of civilians whose occupations demand that they stand for long periods of time. The onset of the disease is usually gradual, and there is no history of a single, dramatic trauma immediately preceding the symptoms.

The typical lesions are almost invariably encountered in the metatarsal bones, usually the second, third, and fourth (6, 9, 11). Involvement of both feet is customarily found. The patients complain of pain, swelling, redness, and tenderness over the dorsum of the feet. Roentgenograms made at the onset of symptoms show no abnormalities. The first radiographic signs appear about eight weeks later when a delicate layer of periosteal new bone formation about the involved metatarsal becomes apparent. A short time thereafter a thin fracture line is noted, and the periosteal new bone formation becomes more distinct, assuming the appearance of a typical callus. The fracture then gradually shows signs of healing, while the callus becomes more compact and fusiform in appearance. Six months after onset complete bony union with absorption of the excessive callus is observed. The shaft appears normal with the possible exception of a slight amount of cortical thickening at the site of the previous fracture (9).

Osteoporosis and malacia have not been described in the communications concerning "march foot." The association of ossifying periostitis with bone atrophy is apparently infrequent. Brainard and Upson (2) published a case of periostitis of the shafts of the second and third metatarsals combined with spotted atrophy of the foot similar to that of the patient we are reporting. No other examples of the condition were found in an extensive review of the literature.

Case Report.—T. P., white male, 43 years of age, presented himself on May 26, 1938, because of pain in the right foot. Three weeks previously a painful swelling at the base of the right second toe spontaneously had appeared. There was a gradual increase in the severity of symptoms until, for several days prior to our seeing him, the pain was constant and prevented sleep. Motion markedly aggravated the pain, and the affected foot was constantly favored. The patient had been wearing a metatarsal pad and arch-supporting shoes for one week prior to observation. He also complained of pain and tenderness in the left tendo achillis region. There were no other complaints, or symptoms referable to systemic disease. No history of dietary deficiencies could be elicited.

For the past two years the patient had been working as a janitor; prior to that he had been employed in a factory. Both occupations required that he be on his feet for long periods of time.

At the age of 12 he had been confined to bed for six months because of "rheumatism of the left hip." No symptoms referable to this condition have since reappeared. There had been no other previous illnesses.

Physical examination demonstrated a swelling over the dorsum of the right second and third toes which extended upward a distance of about 4 cm. onto the dorsum of the foot. There was moderate redness and cyanosis of the overlying skin. The entire area was tender. Exquisite tenderness was present on the plantar aspect of the metatarso-phalangeal joints of the second and third toes. The anterior metatarsal arch was spastic and flattened. Motion of all toes was impaired. The remainder of the examination revealed no abnormalities.

Laboratory Findings.—Blood pressure, 130/80. Blood count: hemoglobin, 85 per cent (Sahli); erythrocytes, 4,200,000 per c.mm.; leukocytes, 8,400 per c.mm.; differential leukocytes, polymorphonuclears, 72 per cent, lymphocytes, 25 per cent, and monocytes, 3 per cent. Blood sedimentation rate: 5 mm. in 1 hour (normal). Blood chemistry: sugar, 110 mgm. per cent; uric acid, 3.5 mgm. per cent (normal 2–4 mgm. per cent). Urine: specific gravity, 1.022; no albumin or sugar present; sediment contained no cells or crystals. Intracutaneous injection of 0.1 mgm. Old Tuberculin resulted in an area of erythema measuring 7.5 × 9.0 cm. There was no slough. Wasser-

[1] Accepted for publication in July, 1939.

Fig. 1. Periosteal new bone formation along the shafts of the proximal phalanges of the second and third toes. Moderate, diffuse osteoporosis present.

mann, negative. Provocative Wassermann (0.3 gm. neoarsphenamine injected one day prior to the test), negative.

Roentgenographic examination of the right foot (Fig. 1) showed the presence of a small amount of periosteal new bone formation along the shafts of the proximal phalanges of the second and third toes. This process was characterized by a duplicated layer of delicately calcified periosteum surrounding the shafts and a slight irregularity and thickening of the cortices of the involved bones. Moderate osteoporosis of the bones of the foot and ankle was also observed. The changes were most apparent in the distal phalanges. Roentgenograms of the left foot and fluoroscopic examination of the chest revealed no abnormalities.

The patient was treated symptomatically. He was advised to rest the extremity and continue wearing the metatarsal pad. Short wave diathermy was given three times weekly. In addition, adequate anti-gout therapy was prescribed. The symptoms remained uninfluenced by the treatment. Roentgenographic examination two and one-half months after the onset of the disease (Fig. 2) revealed no change in the ossifying periostitis. The osteoporosis, however, had markedly increased and involved all the bones of the foot and ankle. Superimposed upon the general bone atrophy were small, circumscribed, circular areas of increased radiolucency. These lesions were most apparent in the phalanges of the first toe, first, third, and fourth metatarsals, cuboid, and cuneiforms. Two months later, although pain continued practically unchanged, another roentgenogram showed a marked improvement of the osteoporosis and almost complete disappearance of the periostitis. A short time thereafter the pain began to regress slowly, and six months after onset the patient again became asymptomatic. Roentgenographic examination of the foot showed complete disappearance of the periostitis and no evidence of osteoporosis (Fig. 3).

The etiology of the periostitis and osteomalacia in our case, as in the majority of cases described, appears to be mild, repeated trauma. There was no history of direct injury and no evidence to suggest infection. The mechanism involved is generally supposed to be the following: prolonged, continuous walking or constant standing ultimately results in a flat foot characterized by marked spasm of the interosseous muscles. The muscular spasm seriously constricts the venous and lymphatic channels in the region, causing circulatory stasis, congestion, and edema. Edema fluid infiltrates and raises the periosteum and produces a mild inflammatory reaction, resulting in an ossifying periostitis. In addition, the local circulatory disturbances impair the nutrition of the bones and make them brittle. As the anterior arch of a weak, flat foot descends, the second and third metatarsal bones become sites of excessive pressure and weight-bearing. The increase in pressure upon the weakened bone ultimately results in fracture.

The initial appearance of the periostitis and the predominant localization of the fracture to the second and third metatarsals are thus best explained. The hypothesis also accounts for many of the observed variations. These include cases with and without symptoms in which only periostitis is found (2, 8), instances in which fracture occurs concomitantly with or precedes the periosteal new bone formation (9), infrequent examples of involvement of the shafts of other metatarsals (6), and very rarely, as in our case, involvement of the shafts of the proximal phalanges.

The osteoporosis present in this case was of a spotty character similar to that described by Sudeck as "acute bone atrophy" (12). It was rapid in onset, continued for about four months, and then began to heal. Its course closely paralleled those of the clinical findings and periosteal new bone formation. Its origin and pathogenesis, however, are not entirely apparent. That the bone atrophy is intimately related to other features of the disease process seems reasonably certain. Staudinger (10) and others (1, 2) have demonstrated that small traumas may cause severe osteoporosis. Investigators agree that local disturbances in circulation are the most important factors in bringing about the atrophy (1, 2, 3, 4). These circulatory disturbances are caused mainly by the vasomotor nerves to the region. Both immobilization and spinal cord reflexes are capable of causing the vasomotor changes in a given region, and in that manner augment

Fig. 2.

Fig. 3.

Fig. 2. Periosteal new bone formation unchanged. Osteoporosis increased.
Fig. 3. Periosteal new bone formation has disappeared. Osteoporosis practically completely healed.

each other in effecting congestion, stasis, and edema about the bone. Bone atrophy results from the impaired circulation and nutrition. Hofmeister and Tanake (5) have suggested that venous and lymphatic stagnation and edema are accompanied by a rise in the CO_2 content of the transudate, and that the increase in the carbonic acid is sufficient to dissolve out the lime salts.

Our own patient presented adequate evidence of local circulatory impairment. Edema, redness, and a small amount of cyanosis were observed over the dorsum of the foot. The changes seemed more closely linked with a vasomotor reflex from the osseous lesion than with the partial immobilization resulting from abortive attempts to rest the involved extremity. However, both factors probably played rôles in producing the osteoporosis.

The disease appeared to behave in a manner quite similar to typical "march foot." It ran a benign course and, aided only by symptomatic treatment, was completely healed in six months. In a number of other instances application of a plaster cast was found to shorten considerably the period of morbidity. This procedure seems indicated only in the more severe cases. An interesting observation in our patient was that roentgen evidence of healing preceded the symptomatic improvement by at least two weeks.

Differentiation of this condition from early tuberculous or non-specific infectious periostitis (7) and gout must be made. Absolute exclusion of tuberculosis could be made only by the clinical course. Infectious osteitis was excluded by the absence of systemic and laboratory signs of infection and by the course. Gout was eliminated by the difference in the roentgenograms, the absence of periarticular bone destruction and tophi, normal blood uric acid value, and failure of response to specific gout therapy.

SUMMARY

A case of periostitis of the shafts of the proximal phalanges of the second and third toes, accompanied by osteoporosis of the entire foot, is presented. The disease appears to be entirely self-limited. Aided only by symptomatic treatment, complete healing occurred within six months. The etiology, pathogenesis, and differential diagnosis of the condition are briefly discussed.

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CALCIFICATION OF THE PERICARDIUM AND WITHIN THE HEART MUSCLE[1]

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During the past few years the literature has contained many reports of the roentgenologic demonstration of calcification of the heart valves which has been diagnosed, usually by fluoroscopic study, and later confirmed by properly made x-ray films.

The reason for reporting this case is because of the extensive calcification present, and because it illustrates the fact that this calcification could easily have been overlooked, had one depended on the teleoroentgenogram for study of this heart and not availed himself of the fluoroscope. The principles of the Bucky grid are well understood—the moving grid does not register on a film. This holds true in studies of the heart, as, with cardiac pulsation, often massive deposits of calcium may be blurred and merged with the heart silhouette, thereby being overlooked (Fig. 1).

The patient to be reported was admitted to Emory University Hospital with a complaint of "heart trouble" of 23 years' duration. He was 37 years of age. His past history indicated that at the age of eight he had puffiness about the eyes, a swelling of his ankles and extremities, and multiple inflamed joints which kept him in bed for several months. An abscessed tooth was removed, and he gradually improved. When 18 years old, he developed edema of the ankles and dyspnea on exertion. At first the symptoms were slight, but, as the years passed, they became progressively worse. One year ago the dyspnea was so severe he was confined to bed. He stopped smoking and, peculiarly, his pulse, which was 100 and regular, dropped to 60 and became irregular. He was digitalized for two weeks and returned to work. He has been taking digitalis for the past year. A month and a half ago he developed a massive edema and has been confined to bed. He was given five doses of salyrgan and the edema disappeared. He has lost considerable weight during the past two months and has a chronic cough. The physical examination, in brief, showed an inflammation of the eyes, chronically inflamed and diseased tonsils, chronic arthritis in multiple joints. Many râles were diffusely spread from the apex to the base of each lung. His heart was irregular, there was no pulse deficit, it appeared enlarged on percussion, the chest wall pulling in with each beat. There was a pronounced pulsus paradoxicus; there were no thrills; his blood pressure was 140/80. His abdomen showed the liver margin 8 cm. down, with questionable liver pulse. He showed a markedly increased venous pressure. The intern's impression

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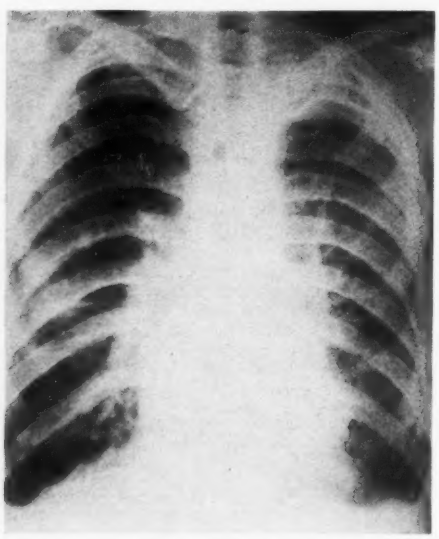

Fig. 1. Teleoroentgenogram, showing no evidence of calcium deposits.

Fig. 2. Tracing of calcium deposits from x-ray film after autopsy.

following history and physical examination was: (1) Congestive heart failure; (2) auricular fibrillation; (3) chronic tonsillitis; (4) adhesive pericarditis; and (5) chronic arthritis.

The laboratory studies showed the Wassermann and Kahn tests to be negative. The sputum was purulent, containing many pus cells, but no acid fast bacteria. The red blood cells numbered 5,300,000; white blood cells 7,500; hemoglobin 85 per cent. He was referred to the x-ray department for examination.

Under the fluoroscope a ragged, irregular, somewhat oval deposit of calcium was seen extending over the entire heart contour (Fig. 2). This tract of calcium had several branches, as well as many discrete calcified masses separate from the main mass. It was irregularly oval in outline. The cardiac pulsations were restricted. The heart was only slightly enlarged. The right and left borders were not smooth as usually seen, but showed a definite irregularity. On deep inspiration there was practically no diaphragmatic excursion. The diaphragms were low, due to an apparent emphysema of the lungs, and did not ascend on expiration. The costophrenic angles were obliterated, possibly by a small amount of fluid, or pleural adhesions. The interlobar pleura on the right between the upper and middle lobe was thickened. From the left costophrenic angle extending upward toward the axilla the parietal and visceral pleura were separated, indicating a small effusion.

The calcification within the heart contour moved slightly with each cardiac pulsation. Evidently, this was within the pericardium, and intimately connected with the heart. The heart was so tightly bound down by the calcification and pericardial adhesions that its excursion was greatly diminished. This study was followed by x-ray films, one made at teleo-distance, and others made on the Bucky diaphragm, postero-anteriorly and laterally, and they all confirm the fluoroscopic report as given above (Figs. 3 and 4). The roentgenologic diagnosis was:

1. Adhesive pericarditis with calcification of the pericardium, and calcium deposits within the heart muscle.
2. Emphysema of both lungs with depression of both diaphragms.
3. Chronic pleurisy, bilateral.
4. Pleural effusion, left lateral thorax.
5. Enlarged liver.
6. A typical Pick's syndrome was present.

After many clinical and laboratory studies the patient was operated upon by D. C. Elkin, M.D., in the hope of decompressing the heart

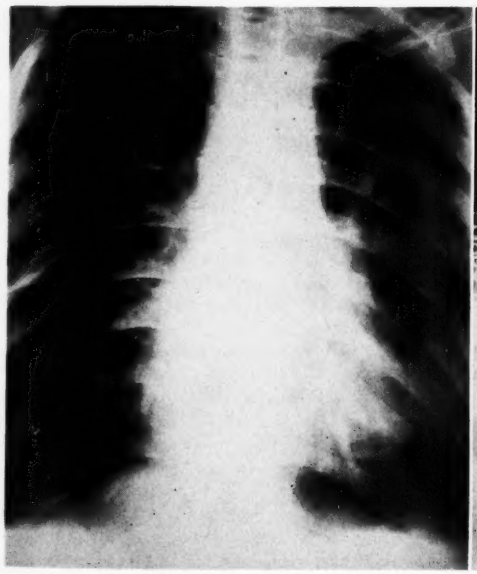

Fig. 3.

Fig. 4.

Fig. 3. Roentgenogram of the heart in anteroposterior position, Bucky diaphragm technic, shows calcified deposits.

Fig. 4. Roentgenogram of the heart, lateral projection, Bucky diaphragm technic, shows calcified deposits.

Fig. 5. Roentgenogram of the heart after autopsy, demonstrating extreme degree of calcium deposits.

by freeing the pericardium. Following is the surgeon's operative report:

"Under positive nitrous oxide and oxygen anesthesia, a semi-circular incision was made reaching from the second to the sixth rib with the base in the anterior axillary line and the periphery at the sternum. After turning back the skin and muscle flap, the second, third, and fourth costal cartilages with about two inches of their ribs were resected. The underlying tissue was firmly adherent to the ribs and pleura and was infiltrated with calcium so that the approach to the heart was difficult and like cutting through shell. The pericardium was reached, however, without opening into the pleura and the surface of the right ventricle was denuded of its overlying calcified and adherent pericardium. The separation was particularly difficult because the scarring ran into the heart muscle. However, it was freed and the heart bulged through the opening. Only the right ventricle and a small portion of the left ventricle were decorticated. All bleeding points were tied with fine silk and the musculocutaneous flap replaced in layers without drainage."

The post-operative course was stormy and the patient died on the seventh day after operation. Autopsy, performed by Roy Kracke, M.D., will not be reported in full, but the anatomic diagnosis was as follows:

1. Adhesive pericarditis with extreme calcification.
2. Bilateral chronic adhesive pleuritis.
3. Old encapsulated empyema, left thorax.
4. Bilateral pulmonary edema.
5. Cirrhosis of the liver.
6. Splenomegaly with extreme fibrosis.
7. Multiple abscesses and tuberculosis of the adrenals.

Microscopic studies were made of the liver, spleen, kidneys, lungs, tracheo-bronchial lymph nodes, adrenals, and pancreas. Examination confirmed the anatomic diagnosis with the additions of extreme fatty degeneration and acute inflammation of the adrenals, plus atrophy and degeneration of the pancreas.

A cross-section from the pericardium showed the tissue to be greatly thickened, with a pronounced fibrosis. In many areas it was two or three times the normal thickness. The visceral and parietal areas were adherent and stuck to the heart wall, and could be separated only by tearing. Microscopically, the section showed a pronounced fibrosis, for the most part, old and mature cells; several areas, however, showed young fibrous tissue cells. The sections were fasciculated and small vessels had been formed. The diagnosis was chronic pericarditis.

Summary.—Calcification within the heart or surrounding the heart is apparently much less often encountered in the South, with its warm temperate climate, than in the North. This patient had lived in Florida all of his life, had had his primary rheumatic heart lesion at the age of eight, and during the next 31 years had developed this extensive calcification of the heart and pericardium, chronic pericarditis with accompanying damage to the lungs, liver, spleen, kidneys, pancreas, and adrenals.

The absolute necessity for fluoroscopic study of such hearts in order to avoid overlooking areas of calcification was well demonstrated in this patient.

A DEVICE TO ALLOW THE USE OF A TOMOGRAPH ON A TILTING TABLE[1]

A PRELIMINARY REPORT

By MILO HARRIS, M.D.,
CHARLES B. WARD, M.D., *and*
E. A. ADDINGTON, M.D., *Spokane, Washington*

The problem which led to the development of this device was one concerned with air myelography in the diagnosis of lesions of the lower spinal canal, particularly ruptured nuclei pulposi. We desired to use a tomograph, but

[1] Presented before the meeting of the Washington State Radiological Society in Spokane, April 7, 1940.

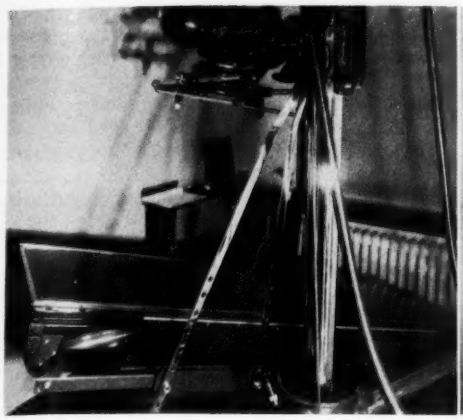

Fig. 1.

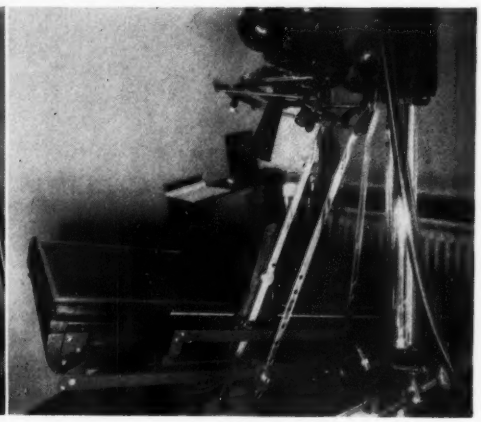

Fig. 2.

Fig. 1. The assembled device showing the extra rail attached parallel to the table top, the carriage, and the two steel rods forming the triangle.
Fig. 2. The complete apparatus with tomograph attached.

this was impossible since the patient must be kept in the Trendelenburg position. The ordinary tomograph requires a horizontal or vertical table, as the tube must run horizontally along the rail or vertically along the tube stand. The device described below allows the table to be placed at any angle, and at the same time the tube always runs parallel with the table by means of a compound motion of the tube carriage on the vertical tube stand and the horizontal rail.

The device consists of three main parts. A separate rail has been attached at the side of the table and parallel with the top by means of two brackets (Fig. 1). This is a steel bar 1/2 × 1 1/4 in. in size. The carriage was made of two pieces of 1/4-in. steel plate 14 in. long between which were mounted four ball-bearing rollers. This was fitted over the extra rail, and the bearings roll in grooves on the top and bottom edges. The third portion of the device consists of two light steel rods made of 3/16 × 1 in. steel perforated for adjustment and attached by means of bolts near the ends of the carriage. Both upper ends are attached together by means of a bolt and thumb nut to the tube carriage on the vertical tube stand, thus forming a triangle. Since the rail is parallel with the table top and the carriage must run along it, then by simple triangulation the tube must also run parallel with the rail and table top.

The tomograph is one made by the Standard X-ray Corporation, and was remodeled to fit the General Electric R-36 table. It consists simply of an arm attached to the tube carriage rails and extends through an adjustable fulcrum to a pivot at the level of the x-ray plate (Fig. 2). This pivot is attached to the Bucky by means of three steel bars arranged to clear the edge of the table.

The device works very satisfactorily as regards the anteroposterior examination of the air-filled spinal canal. This portion of the examination shows extremely well the air-filled subarachnoid space with a definitely outlined dural tube, and occasionally nerve sheaths are clearly visualized (Fig. 3). At the present time we have not been completely satisfied as to the views in the lateral position, but this we hope to overcome with further experience. We have been able definitely to rule out lesions at the lumbosacral junction. With ordinary air myelography, this has been difficult.

Our procedure has been to take ordinary films preliminary to the injection of air so as to rule out anatomic defects in the bone. After the air has been introduced, anteroposterior and lateral plain films are taken. Tomographic views are then made at about one-centimeter intervals until the films necessary for diagnosis have been found. A rotating anode tube is used, but care must be taken not to overheat the target, especially by taking the lateral views at too short intervals between exposures.

We have already found certain defects: the rail fixed to the table should be heavier and wider, since with the present 1/2 × 1 1/4 inch steel bar there is a tendency to vibrate as the tube is moved. The ball-bearing rollers also should be larger than the 7/8-in. outside diameter ones used. The above described apparatus,

Fig. 3. Myelogram made with the device (not retouched). The arrows point to two of the nerve sleeves visualized. Note the distinctly outlined dural sac.

we believe, has definitely increased the accuracy of diagnosis of lesions in the lower spinal canal by air myelography.

252 Paulsen Bldg.

INTERMITTENT HYDRARTHROSIS OF BOTH KNEES[1]

TREATMENT WITH ROENTGEN THERAPY

By HARRY JAY EPSTEIN, M.D., Junior Adjunct, Medical Service No. 2, *and* LOUIS EDEIKEN, M.D., Radiologist, *Philadelphia*

From the Mount Sinai Hospital

In a recent article Berger (1) reviewed the literature of intermittent hydrarthrosis and stated that Perrin (2) had recorded the first case in 1845. The condition is rare, Berger having found but 106 cases. We wish to report an additional patient, successfully treated by roentgen therapy, with freedom of symptoms for the past 26 months.

Intermittent hydrarthrosis is an unusual and peculiar condition of the joints characterized by acute, regularly recurring effusions of fluid into a joint cavity. Its striking features are periodic recurrence and tendency to affect the knee joint. The exact regularity of recurrences is most interesting, the usual interval being ten or eleven days. The average duration of each attack is from four to five days. In the interval between attacks the joint, in most cases, is practically normal. According to Miller and Lewin (3), one or both knees have been involved in every case reported in the literature.

REPORT OF CASE

History.—B. L., white woman aged 33 years, weight 133 pounds (60 kg.), height 65 inches (165 cm.), was admitted to the Mount Sinai Hospital[2] on Jan. 17, 1936, with chief complaint of "swollen knee." Her present complaint dated back to the Summer of 1931, when she was awakened by an acutely painful swollen left knee. Her physician prescribed medication and bed rest. The swelling in the left knee subsided in a few days and then reappeared in the right knee two weeks later. X-rays of both knees were taken at that time and reported to be normal. Treatment was ineffective. The intermittent attacks of swelling and pain recurred at regular intervals of exactly ten days, first in the right knee and then in the left. Since the first attack she has been ambulatory, even with the swelling and pain. At no time was there associated fever. The attacks were not influenced by the menses or any existing infection, or by any allergic concomitant as far as could be determined. As time went on, the episodes of pain became less severe and finally disappeared. In the beginning, the swellings would last four or five days. As the condition became chronic, each individual swelling lasted for a longer period of time, that in one knee frequently overlapping that in the other, so that, at times, both knees would be simultaneously swollen. The patient had been studied very thoroughly, with no clue toward the relief of symptoms. Elimination of skin-sensitive foods failed to give relief. A tonsillectomy had had no effect upon the swelling. Finally, she was persuaded to enter the hospital.

Past Medical History.—She had had whooping cough, measles, chickenpox, and "running

[1] Accepted for publication in September, 1939.

[2] Medical Service No. 2, Dr. A. Trasoff.

ears" in infancy. An appendectomy and a plastic operation had been performed in 1925. Family history was essentially negative except for diabetes in the mother. Social history was significant in that she was an active business woman dealing in furs, which, as she stated, required her hurrying in and out of an automobile from 30 to 50 times daily. Menstrual history was essentially negative. Her periods started at 12 years of age, recurred regularly every 28 days, and lasted for five days. Gastro-intestinal, genito-urinary, and cardio-respiratory histories were essentially normal.

Physical Examination.—Physical examination revealed a white woman, not acutely ill. The blood pressure was 120/80. All physical findings were essentially normal with the exception of the left knee, which was 9 cm. larger in circumference than the right. A very small amount of fluid was detected above the left patella. The joint was not hot, painful, or tender. She was considered a case of typical intermittent hydrarthrosis of unknown etiology. Her studies in the hospital revealed nothing of any etiologic significance. Complete blood count showed 96 per cent hemoglobin (Sahli), 4,800,000 red blood cells, 9,200 white blood cells, 50 per cent polymorphonuclears, 48 per cent lymphocytes, 2 per cent transitionals. Blood urea nitrogen 11 mg. per 100 c.c. of blood, blood sugar 105 mg. per 100 c.c. of blood, blood chlorides 560 mg. per 100 c.c. of blood, non-protein nitrogen 38 mg. per 100 c.c. of blood, blood cholesterol 155 mg. per 100 c.c. of blood, total proteins 7.8 gm. per 100 c.c. of blood plasma, serum albumin 6.04 gm. per 100 c.c. of blood plasma, serum globulin 1.76 gm. per 100 c.c. of blood plasma, blood calcium 11.8 mg. per 100 c.c. of blood, blood phosphorus 3.6 mg. per 100 c.c. of blood, blood Wassermann negative. Basal metabolism, minus 14. Endocrine studies including estimation of anterior pituitary hormone in the blood were normal. Neurologic, gynecologic, gastro-intestinal, and nose and throat studies were of little help. Allergic studies revealed sensitivity to olives, string beans, corn, oats, and potatoes, goat epithelium, and silk. All patch tests were negative. Elimination of the sensitive foods failed to give relief. X-ray examination of both knees was normal. An exploratory aspiration of the knee was refused. Her temperature, pulse, and respirations were always normal.

While in the hospital she was given autohemotherapy—10 c.c. of whole blood intramuscularly every third day. Calcium lactate, dilute hydrochloric acid, ephedrin, and extract of thyroid were ineffective. After her discharge from the hospital, autohemotherapy, calcium gluconate, intravenously, thyroid extract by mouth were continued without any noticeable effect upon the swelling.

On March 27, 1937, there appeared in the abstract section of the *Jour. Am. Med. Assn.* (4) an article on periodic hydrarthrosis of the knee cured by local roentgen therapy. According to this article a patient who had had intermittent hydrarthrosis for 20 years was treated with x-ray therapy with relief for the following ten months. This form of therapy was suggested to our patient and carried out with her consent. Irradiation was started on April 12, 1937, the following factors being used: 132 kv., 5 ma., 35 cm. S.T.D., and 0.25 mm. copper filter. The field was 10 × 15 cm.

Treatments were given at weekly intervals to the internal and external aspects of both knees. At each sitting 210 r was given to each field. Between April 12 and April 28, 1937, a total of 731 r was given to each field. On May 12, 1937, treatment was given through the anteroposterior and postero-anterior fields of each knee. Between May 12 and June 2, 1937, 636 r was given to each field. Since then no irradiation has been given.

The swelling disappeared after one month of x-ray therapy. The patient stated at that time that there was no limitation of motion and that the joint was perfectly normal. For the past 26 months there has been no recurrence. The patient has been ambulant, and exercises, in addition to pursuing her business activities.

Summary.—A case of intermittent hydrarthrosis of both knees of six years' duration is presented. The patient was successfully treated by irradiation, and for the past 26 months has had no recurrence of attacks.

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1832 Spruce Street

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MEDICAL SERVICE[1]

May I first express my appreciation of the honor you do me in granting me a place on your program and then, as a surgeon, pay a brief tribute to your specialty, without whose aid surgery would lose much of its accuracy. The practice of holding annual meetings at which the advances of the year are presented is evidence of a desire not only to recognize such accomplishments but to encourage those of present and future generations in their efforts to further the advance of medicine. The science of roentgenology has developed within the memory of many of those present, certainly within my memory, and as yet its rôle in the medical firmament cannot easily be appraised; it is, I think, a safe prediction that any present evaluation of roentgenology in the science of medicine will, in retrospect, be found an under-estimation. The application of its science has made it an essential factor in diagnosis in a greater number of diseases than is true of any other method and this application is steadily becoming more comprehensive. Since the whole structure of therapeutics rests on accuracy in diagnosis, the importance of this fact cannot be exaggerated. Many of the most serious diseases, notably internal cancer, fail to give rise to any clinical signs or symptoms in their early stages, and frequently roentgenology makes recognition possible at a time when there is the most favorable situation for bringing about a cure. As a surgeon, I have been impressed with the fact that the interpretation of the revelations of the roentgenogram and the fluoroscope and the evaluation of these findings as related to the clinical symptoms by the joint efforts of the roentgenologist and the clinician have done much to clarify the diagnosis of lesions and abnormalities involving every portion of the body. Taking the gastro-intestinal tract as an example, I think it may be safely said that roentgenology has contributed more than any other factor to the advancement and perfection of our knowledge in this field. The roentgenologist will, with experience, find in the behavior of the stomach of the patient with duodenal ulcer certain suggestions as to what will be the most successful operation. When the patient has marked obstruction from duodenal ulcer, impairment of motility, as shown under the fluoroscope, indicates, or at least clearly suggests, that relief of this impairment is all that is necessary. When the stomach shows great hyperactivity, the operation of gastro-enterostomy, so effective when an obstruction exists, does not bring about as satisfactory results, for it is this very hyperactivity that makes possible the development of recurrent lesions. The results of duodenal ulcer show it to be a disease that can be controlled in about 80 per cent of cases by the coordinated efforts of the roentgenologist, the physician, and the surgeon. Duodenal diverticulum is an example of a condition that can be detected only by the radiologist, the symptoms being so vague that a diagnosis on clinical grounds is impossible. The early diagnosis of cancer of the stomach is made possible only with the assistance of the roentgenologist, and any improvement in the operative cure of this malady is to be ascribed to the aid afforded by the x-ray. Again, in advanced carcinoma of the stomach, the cooperation of the roentgenologist, the clinician, and the surgeon is essential in deciding whether or not the operation is worth while. Gastric ulcer is probably less common than carcinoma and the situation of the lesion, whether on the greater or lesser curvature, and its roentgenologic aspects are of the utmost importance in determining the treatment. Persistent and recurrent pylorospasm as revealed to the roentgenologist is an important contribution in its relationship to intragastric disease.

One could take each and every part of the human body and multiply instances comparable to those just cited. The total number of radiologists is comparatively small, but your specialty is of ever-growing importance in all branches of medicine, uniting many interests by the wideness of its appeal. Its scope as a diagnostic aid has found its way into every

[1] Address before the American College of Radiology, June 12, 1940.

branch of medicine and surgery and has become so useful as to be absolutely indispensable. Roentgenologists are, in reality, consulting diagnosticians who possess knowledge of x-ray anatomy, x-ray physiology, and x-ray pathology, and upon whose findings the diagnosis must in many instances depend.

It is trite to say to this audience that the interpretation of x-ray findings should be restricted to those trained in this work. The x-ray itself makes no mistakes, but the judgment of the interpreter is not infallible. As in all branches of medicine, the greater the experience the riper the judgment. Irradiation alone has become a successful and well established therapeutic measure against many affections, the radiologist thereby qualifying as an independent therapeutic specialist. There is still in some quarters a disposition to look upon the radiologist as a technician or medical photographer and to dispense his services on this basis. I know of no branch of medicine in which more expert knowledge is required, both as a physician and a physicist, before one may be justly designated as an expert therein.

The six great radiologic organizations, the Radiological Society of North America, the American Roentgen Ray Society, the American Radium Society, the Section on Radiology of the American Medical Association, and the American College of Radiology, with the American Board of Radiology attest the standing and domain of this specialty and symbolize the advance of this branch of medicine. As a surgeon, I pay my respects and congratulations and offer my admiration to you for the constructive results of your efforts. Particularly do I wish to congratulate you on your efforts to retain and maintain your professional status. The efforts which have been made to dispense your knowledge and experience as part of a hospital service are not only fundamentally wrong from an ethical viewpoint, but, if tolerated and accepted, are but the entering wedge for the dispensation of all professional services on such a scale. The proponents of such schemes fail to make a distinction between the ethics of commerce and the ethics of medicine, the former based on the amount of goods that can be sold in the market, the latter upon the welfare and the good of the community. Medicine fits into the entire broad field of economics as does the exchange of any other services or goods for services or goods. In recent years we have heard much of the "production of medical care," "consumption of medical care," and the "distribution of medical care." There is no such thing as the "production of medical care," unless we mean the birth, education, and training of doctors. There is no such thing as its "distribution," unless we mean doctors attending sick people. There is no such thing as "consumption" of medical care, unless we mean persons being helped by doctors. In the fields of commerce such terms are apt. Costs of production are cut by mass methods of manufacture; costs of distribution are reduced by co-operative buying in quantity; consumption is increased by lowering the cost and the selling price of the product. When we apply such terms to medical care, we take the connotations along and assume that the subject matter is susceptible to the application of the principles which the terms imply, and that is not true. Human knowledge and intelligence cannot be dispensed in boxes or crates as a commodity; they simply do not fit into such a concept of economics. For example, the co-operative philosophy of reducing costs is based upon quantity purchasing and the elimination of the middleman. Medical care cannot be purchased in quantity. In the first place, it is not "purchased" at all, it is employed. There cannot be any such thing as quantity in a personal relationship; there can be quality but not quantity. Can 100 x-ray examinations be ordered to-day and delivered to-morrow? If so, to whom? And may the so-called "consumers" reject them on a money-back guarantee, if they do not like them? Can time elements in treatment be computed and a system of cost-accounting evolved? Are the hospitals to determine the value of your services to them and then profit by the sale of such? If so, then we will have middlemen to our everlasting confusion. Any attempt to make the method of reward or financial gain, either to patient, physician, or lay administrator, the basis of the organization of medical service, with domination of these considerations over the giving of medical service, or that seeks to produce and distribute such service according to competitive standards of cheapness backed by salesmanship methods, violates the fundamental principles of medical ethics and invites the medical profession to surrender its ideals and to perish.

The Principles of Medical Ethics have been criticized by lay people and even by some members of our profession as obsolescent and anti-

quated. It is readily admitted that the underlying principles are ancient, having been enunciated in the Hippocratic Oath written years before the birth of Christ, but it is submitted that the age-old principles are the only ones, whether in the ethics and economics of medicine or industry, that have stood the test of time. These Principles contain the self-imposed obligation of the profession to give of its service to those unable to pay, and the implication that those in the lower income levels may obtain service at a cost they can afford to meet. Many of the component units of the American Medical Association are at present engaged in experimenting with plans designed to bring service to these groups. These efforts deserve the support of such bodies as the College of Radiology to the end that the advantages and blessings of scientific medicine may be made available to all the people and that the service afforded will be good service; in other words, of uniform quality, not superior for one group and inferior for another. The social trends of American medicine are in harmony with its long established principles and policies which are directly concerned with the welfare of the public. Whatever plan is proposed in regard to medical care is automatically tested and accepted or rejected in relation to its influence on the morbidity and the mortality of the community affected. Reward or financial gain is to be a subordinate consideration. While good medical service cannot be expected unless society appreciates it sufficiently to financially reward those rendering it, it is equally true that a profession that seeks first financial reward becomes commercialized in spirit and mediocre or negative in scientific attainment.

To those of us who have witnessed the rise and development of your specialty has been accorded a great privilege, that of living through and taking part in a remarkable transition period in the fruition and development of the art and science to which we bear allegiance. Medical science has made greater progress during our lifetime than in any previous period. Much of the newer work has been created and practically all has been evolved since our student days. Beginning our careers in the waning shadow of one school of thought, that founded on clinical observation alone, we have witnessed the growth and development of modern medicine, seeing in this Golden Age the beautifully integrated structure built upon accurate, scientific knowledge. Remarkable advances and progress are being charted in every field, but the words of Dr. George Shattuck, uttered as far back as 1866, still hold true: "No one can deny or doubt that we have made and are making great advances, but the horizon opens before us as we go on, and the extent of the field becomes even more apparent than our progress." We of to-day in medicine have a noble heritage, being the intellectual descendants of all the great minds who have heretofore charted its course. Realizing our commitment to the traditions established by our forebears and our responsibilities to the background of the past, we salute an even more brilliant future.

IRVIN ABELL, M.D.

RADIOLOGICAL SOCIETIES IN NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

UNITED STATES

CALIFORNIA

California Medical Association, Section on Radiology.—Chairman, Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles; *Secretary,* Carl D. Benninghoven, M.D., 95 S. El Camino Real, San Mateo.

Los Angeles County Medical Association, Radiological Section.—President, M. L. Pindell, M.D.; *Vice-president,* Richard T. Taylor, M.D.; *Secretary,* Wilbur Bailey, M.D., 2007 Wilshire Blvd.; *Treasurer,* Henry Snure, M.D., 1414 South Hope Street; Kenneth Davis, M.D., *Member of Executive Committee.* Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Chairman, William E. Costolow, M.D., Los Angeles; *Members of Executive Committee,* I. S. Ingber, M.D., San Francisco; D. R. MacColl, M.D., Los Angeles, and J. D. Coate, M.D., Oakland; *Secretary-Treasurer,* L. Henry Garland, M.D., 450 Sutter St., San Francisco. Executive Committee meets quarterly; Society meets annually during annual meeting of the California Medical Association.

San Francisco Radiological Society.—Secretary, Harold A. Hill, M.D., 450 Sutter Street. Meets monthly on third Thursday at 7:45 P.M., for the first six months at Toland Hall (Univ. of Calif. Med. School) and for the second six months at Lane Hall (Stanford Univ. School of Med.).

COLORADO

Denver Radiological Club.—President, N. B. Newcomer, M.D., 306 Republic Bldg.; *Vice-president,* Elizabeth Newcomer, M.D.; *Secretary,* Paul R. Weeks, M.D., 520 Republic Bldg.; *Treasurer,* L. G. Crosby, M.D., 366 Metropolitan Bldg. Meets third Friday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Chairman, Owen J. Groark, M.D., 881 Lafayette St., Bridgeport; *Secretary-Treasurer,* Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

FLORIDA

Florida Radiological Society.—President, J. H. Lucinian, M.D.; *Vice-president,* John N. Moore, M.D.; *Secretary-Treasurer,* Elliott M. Hendricks, M.D., 314 Sweet Bldg., Fort Lauderdale. Meetings held in November and at the annual meeting of the Medical Association of Florida in the spring.

GEORGIA

Georgia Radiological Society.—President, Robert Drane, M.D., DeRenne Apts., Savannah; *Vice-president,* J. J. Collins, M.D., Archbold Hospital, Thomasville; *Secretary-Treasurer,* Robert C. Pendergrass, M.D., Prather Clinic Bldg., Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—President, Adolph Hartung, M.D.; *Vice-president,* Warren W. Furey, M.D.; *Secretary,* Chester J. Challenger, M.D., 3117 Logan Blvd. The Society meets at the Palmer House on the second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—President, Harry W. Ackeman, M.D., 321 W. State St., Rockford; *Vice-president,* D. R. Hanley, M.D., St. Mary's Hospital, Streator; *Secretary-Treasurer,* William DeHollander, M.D., St. John's Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Chairman, Warren W. Furey, M.D., 6844 Oglesby Ave., Chicago; *Secretary,* Harry W. Ackeman, M.D., 321 W. State St., Rockford.

INDIANA

The Indiana Roentgen Society.—President, H. H. Inlow, M.D., Shelbyville; *President-elect,* Charles Wyeth, M.D., Terre Haute; *Vice-president,* C. A. Stayton, M.D., Indianapolis; *Secretary-Treasurer.* Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—President, D. B. Harding, M.D., Lexington; *Vice-president,* I. T. Fugate, M.D., Louisville; *Secretary-Treasurer,* Joseph C. Bell, M.D., 402 Heyburn Bldg., Louisville. Meeting annually in Louisville, third Sunday afternoon in April.

MAINE

See New England Roentgen Ray Society.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Chairman, Harold E. Wright, M.D., 101 W. Read St.; *Secretary,* Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

MASSACHUSETTS

See New England Roentgen Ray Society.

MICHIGAN

Detroit X-ray and Radium Society.—President, O. J. Shore, M.D., 552 Fisher Bldg., Detroit; *Vice-president,* Clarence E. Hufford, M.D., 421 Michigan St., Toledo, Ohio; *Secretary-Treasurer,* E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

Michigan Association of Roentgenologists.—President, J. H. Dempster, M.D., Detroit; *Vice-president,* L. E. Holly, M.D., Muskegon; *Secretary-Treasurer,* J. E. Lofstrom, M.D., 1536 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—President, Harry Weber, M.D., Mayo Clinic, Rochester; *Vice-president,* G. T. Nordin, M.D., Minneapolis; *Secretary,* John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

MISSOURI

The Kansas City Radiological Society.—President, L. G. Allen, M.D., 907 N. 7th St., Kansas City, Kansas; *Secretary,* Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—President, Oscar C. Zink, M.D., St. Luke's Hospital; *Secretary,* Wilbur K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of October, January, March, and May, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—President, Roy W. Fouts, M.D., 1007 Medical Arts Bldg., Omaha; *Secretary,* D. Arnold Dowell, M.D., 816 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *Secretary,* Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW HAMPSHIRE

See New England Roentgen Ray Society.

NEW JERSEY

Radiological Society of New Jersey.—President, James G. Boyes, M.D., 912 Prospect Ave., Plainfield; *Vice-president,* Nathan J. Furst, M.D., 190 Johnson Ave., Newark; *Secretary,* W. James Marquis, M.D., 198 Clinton Ave., Newark; *Treasurer,* H. A. Vogel, M.D., 1060 East Jersey St., Elizabeth, and *Counsellor,* H. J. Perlberg, M.D., 921 Bergen Ave., Jersey City. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.—President, I. J. Landsman, M.D., 910 Grand Concourse, New York City; *President-elect,* D. E. Ehrlich, M.D., 35 West 92nd St., New York City; *Vice-president,* Frederic E. Elliott, M.D., 122 76th St., Brooklyn; *Treasurer,* Solomon Fineman, M.D., 133 East 58th St., New York City; *Secretary,* William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—President, A. L. L Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts.; *Secretary-Treasurer,* L. J. Taormina, M.D., 1093 Gates Ave. Meetings first Tuesday in each month at place designated by president.

Buffalo Radiological Society.—President, Edward Koenig, M.D., 100 High St., Buffalo; *Vice-president,* W. Roger Scott, M.D., 598 Pine St., Niagara Falls; *Secretary-Treasurer,* Joseph S. Gian-Franceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen Ray Society.—President, Albert Lenz, M.D., 613 State St., Schenectady; *Vice-president,* Dwight V. Needham, M.D., 123 Sedgwick St., Syracuse; *Secretary-Treasurer,* Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—President, Samuel G. Schenck, M.D., Brooklyn; *Vice-president,* G. Henry Koiransky, M.D., Long Island City; *Secretary,* Marcus Wiener, M.D., 1430 48th St., Brooklyn; *Treasurer,* Louis Goldfarb, M.D., 608 Ocean Ave., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—President, Henry K. Taylor, M.D., 667 Madison Ave., New York City;

Vice-president, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains, N. Y.; *Secretary*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City, and *Treasurer*, Paul C. Swenson, M.D., 168th St. and Broadway, New York City.

Rochester Roentgen-ray Society.—Chairman, George H. S. Ramsey, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—President, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

OHIO

Ohio Radiological Society.—President, U. V. Portmann, M.D., Cleveland; *Secretary*, J. E. McCarthy, M.D., Cincinnati. A committee was appointed to draw up a constitution and by-laws. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—President, L. A. Pomeroy, M.D., Hanna Bldg., Cleveland; *Vice-president*, P. C. Langan, M.D., 215 Wellsley Ave., Akron; *Secretary-Treasurer*, H. A. Mahrer, M.D., 10515 Carnegie Ave., Cleveland. Meetings at 6:30 P.M. at the Mid-day Club, in the Union Commerce Bldg., on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*President*, Samuel Brown, M.D.; *Secretary-Treasurer*, Justin E. McCarthy, M.D., 707 Race St. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—President, H. Norton Mawhinney, M.D., Pittsburgh; *President-elect*, Peter B. Mulligan, M.D., Ashland; *First Vice-president*, Harold S. Callen, M.D., Bradford; *Second Vice-president*, Harold W. Jacox, M.D., Pittsburgh; *Secretary-Treasurer*, L. E. Wurster, M.D., 416 Pine St., Williamsport; *Editor*, William E. Reiley, M.D., Clearfield; *Assistant Editor*, Sydney J. Hawley, M.D., Danville; *Censor for Three Years*, A. R. Snedden, M.D., McKeesport. The Society meets annually; time and place of next meeting will be announced later.

The Philadelphia Roentgen Ray Society.—President, Jacob H. Vastine, II, M.D., Medical Arts Bldg., Philadelphia; *Vice-president*, A. Maxwell Sharpe, M.D., 708 Sproul St., Chester; *Secretary*, Barton R. Young, M.D., Temple University Hospital, Philadelphia; *Treasurer*, Fay K. Alexander, M.D., Chestnut Hill Hospital, Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

The Pittsburgh Roentgen Society.—President, Paul G. Bovard, M.D., 306 Corbett St., Tarentum, Pa.; *Vice-president*, John H. Gemmell, M.D., 262 Connecticut Ave., Rochester, Pa., and *Secretary-Treasurer*, Harold W. Jacox, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings held second Wednesday of each month at 4:30 P.M., from October to June, at various hospitals designated by program committee.

RHODE ISLAND

See New England Roentgen Ray Society.

SOUTH CAROLINA

South Carolina X-ray Society.—President, T. A. Pitts, M.D., Columbia; *Secretary-Treasurer*, Malcolm Mosteller, M.D., Columbia Hospital, Columbia. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—President, Eugene Abercrombie, M.D., 305 Medical Arts Bldg., Knoxville; *Vice-president*, Christopher C. McClure, M.D., 404 Doctors Bldg., Nashville; *Secretary-Treasurer*, Franklin B. Bogart, M.D., 311 Medical Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—President, C. F. Crain, M.D., Corpus Christi; *President-elect*, M. H. Glover, M.D., Wichita Falls; *First Vice-president*, G. D. Carlson, M.D., Dallas; *Second Vice-president*, P. E. Wigby, M.D., Dallas; *Secretary-Treasurer*, L. W. Baird, M.D., Scott and White Hospital, Temple. Meets annually. The next annual meeting is to be Jan. 18, 1941, in Sherman.

VERMONT

See New England Roentgen Ray Society.

VIRGINIA

Virginia Radiological Society.—President, Wright Clarkson, M.D., Petersburg; *Vice-president*, Clayton

W. Ely, M.D., Norfolk; *Secretary*, Charles H. Peterson, M.D., 603 Medical Arts Bldg., Roanoke.

The annual meeting of the Virginia Radiological Society was held at the Greenbrier Hotel, White Sulphur Springs, West Virginia, on July 29, 1940. This society meets annually in October, but the meeting this year was held earlier in order to coincide with the joint meeting of the Virginia and West Virginia Medical Societies.

WASHINGTON

Washington State Radiological Society.—President, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Vice-president*, George Cornett, M.D., Yakima; *Secretary-Treasurer*, Kenneth J. Holtz, M.D., American Bank Bldg., Seattle. Meetings fourth Monday of each month at College Club, Seattle.

WISCONSIN

Milwaukee Roentgen Ray Society.—President, H. W. Hefke, M.D.; *Vice-president*, Frederick C. Christensen, M.D.; *Secretary-Treasurer*, Irving I. Cowan, M.D., Mount Sinai Hospital, Milwaukee. Meets monthly on first Friday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

CANADA

Section on Radiology, Canadian Medical Association.—Chairman, Gordon Richards, M.D., Medical Arts Bldg., Toronto; *Secretary*, W. J. Cryderman, M.D., Medical Arts Bldg., Toronto.

Section on Radiology, Ontario Medical Association.—Chairman, E. H. Shannon, M.D., St. Michael's Hospital, Toronto; *Secretary*, W. J. Cryderman, M.D., 474 Glenlake Avenue, Toronto.

Canadian Association of Radiologists.—President, J. E. Gendreau, M.D., Montreal; *Vice-president*, W. H. McGuffin, M.D., Calgary; *Honorary Secretary-Treasurer*, W. L. Ritchie, M.D., Montreal; *Chairman of Interrelations Committee*, G. E. Richards, M.D., Toronto.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

THE TERMINOLOGY OF THE ROENTGENOLOGIST

The discovery of the roentgen ray, in 1895, opened a new chapter in medical history. As in any newborn science, the terminology did not keep pace with the rapid advances. A considerable amount of the roentgen vocabulary was borrowed, chiefly from pathology and anatomy. Meanwhile some workers were coining words to describe these new phenomena. "The remarkable increase of words in medical literature," states W. R. R. Phillips,[1] "is due chiefly to the abandonment of Latin as the universal language of medicine, the introduction of the vernacular, and the contributions of other sciences."

With such a variety of origins, is it any wonder that roentgenologists can describe the identical pathologic condition in so many different ways?

"Mathematicians ages ago," writes Phillips,[1] "realized the imperativeness of conformity in the use of fundamentals of their science; so, too, the chemists with respect to early symbols. Physicists have agreed on their units; the human anatomists reduced anatomic nomenclature from some 60,000 to 5,000 terms: the 'Basal Nomina Anatomica.'" Clearly a time has come when systematic arrangement should be established, but before we can improve our position, we must first understand the connotation of frequently used terms.

The necessity for reform in the field of terminology and of reporting appears highly desirable. There are essentially two main methods of reporting; one is the bald recital of roentgen signs with diagnosis. This requires of the roentgenologist nothing but accurate vision and good descriptive powers. It is bound to be verbose. The other extreme is merely to state the x-ray diagnosis, which is economical of time and effort, but fails to justify the opinion. Unfortunately this is the procedure adopted in large city institutions where mass-production methods are employed. The roentgenologist is required to interpret from seventy-five to one hundred cases, or more, per day, depending upon the exigencies of the seasons or other local demands.

In the first method the roentgenologist too often is prone to lose the science of clinical medicine. He becomes merely a cog in a machine-like diagnostic laboratory. In the second method, the general practitioner cannot understand on what basis the diagnosis has been made. His own knowledge of the case has not been materially advanced, nor has his experience been enriched. "To insure the most effective use of x-ray findings," Enfield[2] states, "they must be interpreted in the light of clinical data."

It is my impression that the modern roentgenologist should determine further diagnostic procedures. For example, frequently in intravenous work, one notes the failure of one kidney to excrete the dye. Some roentgenologists report: "Non-filling of right kidney." The sensible report should be: "The right kidney failed to excrete the dye, even 5, 10, or 20 minutes following intravenous injection. A retrograde pyelogram is suggested. Until then, diagnosis is suspended." This, at least, proposes the way for further study; then by a comparative re-examination, a diagnosis may be established. "Non-filling" is not a diagnosis of a disease; it is merely a vague term which cloaks our ignorance. The only logical conclusion is to suggest the proper future procedure and to abstain definitely from making a diagnosis. In cases in which roentgenologists cannot make distinct contributions, they should state their limitations.

Similarly, in reporting roentgenograms of the gall bladder by the oral method of ad-

[1] PHILLIPS, W. R. R.: Medical Nomenclature, Desirability of Reform. Jour. South Carolina Med. Assn., **19**, 397–402, February, 1923.

[2] ENFIELD, C. D.: Jour. Am. Med. Assn., **80**, 999-1001, April 7, 1923.

ministration of the dye, the term "non-filling" is not a diagnosis, but merely a physiologic aberration. This illustrates how a pathologic report induces confusion. Here, also, the correct procedure would be to suggest an intravenous gall-bladder examination or, in cases in which indicated, another oral gall-bladder examination. If non-filling recurs, a sensible report might read as follows: "The dye failed to visualize the gall bladder; whether it is due to an obstruction, tumor, or cholecystitis cannot be determined roentgenologically." Then the only reasonable "diagnosis" would be "pathologic hepatic system." The roentgenologist cannot diagnose the disease with accuracy. He knows that for a perfectly filling gall bladder several conditions must be fulfilled, and he can easily adduce when all these factors have been satisfied. Should one factor be irreparable, a non-filling is evident. If it is a non-filling gall bladder, he cannot be expected to give definite information, he can only record his observation and state the limitation of the examination. We must remember that this type of examination is merely a gauge of physiologic activity rather than an actual index of degree of disease involved.

A third illustration of this type of reporting concerns x-ray films of the chest. Frequently the referring physician receives this bright piece of information: "Radiologic examination of the chest shows an area of veiling (or consolidation) over the lower left lung-field." Considering the numerous conditions which cause a "consolidation," it is unfair to expect the general practitioner to proceed intelligently with the treatment of his patient on the basis of such a "diagnosis." The physician has had reasons to believe a consolidation was present merely on the basis of his physical findings; he wants precise information. The roentgenologist must be prepared, if possible, to give it. His position is actually comparable to that of a consultant.[3] It is the roentgenologist's duty to review the case history, laboratory findings, etc., and these data, taken in conjunction with the x-ray films, should enable him to establish the diagnosis of pneumonia, tumor, atelectasis, etc. If the roentgenologist finds it difficult to establish a diagnosis, or the clinical data are insufficient, then why does he not state the diagnostic possibilities, thereby, at least, corroborating the clinician's viewpoint? No one is aided by a "diagnosis" of "veiling," "consolidation," or of "areas of decreased illumination." It must be re-affirmed that these latter terms are stages of pathologic activity rather than diagnoses of different diseases.

Another frequently abused term is the so-called diagnosis, "elevated diaphragm." The physician generally is aware of this on the basis of his physical examination; he wants to know the cause. Fluoroscopic examination is extremely important here. Gall-bladder studies or even perhaps thorotrast studies in properly selected cases are indicated, but it is necessary to seek definitely to eliminate many clinical entities. The end-result might be a congenital anomaly. Our duty is to explain this condition to the best of our ability, not to sit by nonchalantly and report "elevated diaphragm." Who is helped by that? "The proper study of mankind is man," states Pope, but the proper study of roentgenology necessarily is clinical medicine and not shadow demarcations and delineations.

This brings up the question of roentgen terminology. Many terms are not only obscure but highly confusing. I shall try to elucidate some frequently used words, since correct reporting presupposes accurate and precise word images.

Such a term is the much-abused "consolidation." In this condition Sante[4] states that the lung loses its air content, assuming a dense, solidified state. This obstructs the x-rays in their passage to the film and appears as an opaque area. If it is homogeneous in appearance, it is probably due to a generalized outpouring of exudate into the air spaces or to their obliteration by tumor or atelectasis. If appearance is mottled and irregular, it is more probably of a type which results from coalescence of infiltrations. Conditions which cause the appearance of consolidation of the x-ray film are: lobar pneumonia, atelectasis, tumor, extra-pleural effusion, lung abscess, chronic diffuse fibrosis, pleural thickening. How inadequate to list "consolidation" as an x-ray diagnosis!

Infiltrations, according to Sante, are rounded, isolated areas, of increased density, varying from pinhead to a centimeter in size. These represent points of bacterial inoculations with the surrounding inflammatory reaction. The minute solidified areas, being denser than the air-containing lung, cast definite shadows on

[3] JONES, W. A.: Points of Mutual Interest to the General Practitioner and the Radiologist. Canadian Med. Assn. Jour., **39**, 152–157, August, 1938.

[4] SANTE, L. R.: The Chest. Paul B. Hoeber, Inc., New York City, 1935.

the x-ray film. Conditions causing this are: miliary tuberculosis, miliary bronchopneumonia, miliary carcinomatosis, dust inhalation, actinomycosis, septic pneumonia, and secondary carcinoma and sarcoma. "Infiltrations, miliary type"—the all-embracing "diagnosis"!

Another phrase often used in the current medical literature is "irregular bulb" in reporting, I assume, gastro-intestinal anomalies. The normal bulb, according to the standard texts on the subject, is "dunce-cap shaped." Any deviation from this criterion can be considered "irregular." When one considers the infinite number of phases of the bulb in its varying spasticities, adhesions, displacements, etc., one readily understands that "irregular bulb" simplifies reporting. For that, I maintain, we do *not* need roentgenologists. A well trained technician accustomed to seeing large numbers of multigram exposures for gastro-intestinal studies can discern an irregular bulb as well as any physician. The doctor should go beyond that—therein lies the skill of his interpretation. Alas, how few of us do! The result is that roentgenologists ultimately achieve the status, not of consultants, but of technicians. How often the patient unintentionally hits the nail on the head when he says, admiringly, "Those were good 'pictures' you took, Doctor." Obviously, then, our reputation is adjudged not by our skill in interpretation, but because our x-rays have met the lay standard of good photography.

The fault lies in poor reporting, inordinate laziness, failure to assume a just responsibility.

And why such poor reporting, you may ask.

Simply because such words as these have been permitted to creep into our vocabulary: enlarged liver, irregular bulb, atonic colon, hypotonic colon, ptotic transverse colon, functional gastric disturbance. A correct approach would be to state that the gastro-intestinal tract does (or does not) show signs of organic lesion, of visible niches, or displaced masses; something tangible. If we do not find these criteria, the x-ray is essentially negative or a re-examination is suggested.

The listing and defining of words might be continued *ad infinitum ad nauseam*. However, I am not compiling a dictionary. I have tried to make clear the necessity for further work in this highly neglected field.

The callous acceptance of present-day methods of reporting; the use of ill-chosen, meaningless terms will, it is feared, stifle interest and prevent necessary reform. The solution is threefold:

1. Render a diagnosis, in cases in which it is possible.
2. When necessary, suggest further tests or state limitations of the particular examination. "If no calculus is found in urinary tract, state only 25 per cent of bladder stones, 15 per cent of ureteral stones, and 10 per cent of kidney stones are not demonstrable, by roentgenologic methods," as Enfield[2] proposes.
3. In instances in which no diagnosis is possible, specifically state differential possibilities. The only danger is that roentgenologists may do this too frequently, thereby gaining a reputation for "hedging."

At present, many of us are disguising our ignorance by calling the rose by another name. Who is helped by the indifference which marks our calling? Is it the patient whose well-being demands an accurate diagnosis? Is it the practitioner who seeks a ray of light? Is it the roentgenologist who lessens by careless reporting the incalculable benefits of the x-ray?

STEPHEN N. TAGER, M.D.
New Rochelle, N. Y.

ANNOUNCEMENTS

NEXT ANNUAL MEETING

THIRD ANNUAL REFRESHER SERIES

POST-GRADUATE COURSES

To be presented by the Radiological Society of North America, Inc., Dec. 1–6, 1940, at Hotel Statler, Cleveland, Ohio.

The Executive Committee has ruled that there will be no charge for enrollment. Members of the Radiological Society will be accorded preferential enrollment and enrollments will be accepted in the order in which they are received. The total number of enrollments will be limited by the seating capacity of the room to which the course is assigned. Admission by ticket only.

The courses have been so arranged that those interested in a particular subject may enroll in a related series throughout the week. Some of the courses are completed in a single session,

others are divided and presented sequentially. All courses should be enrolled for in their entirety. No course is repeated during this series.

Mimeographed copies of notes will be available in all but a few of the courses offered.

Please read the descriptions of the courses, noting particularly the days upon which they are offered, study the diagram of the plan of presentation carefully, and mark the enrollment diagram correctly, that correspondence concerning errors in enrollment may be avoided.

The following is a description of the Refresher Series, Post-graduate Courses.

Course No. 1. RADIOLOGY OF THE STOMACH, DUODENUM, AND GALL BLADDER: E. P. Pendergrass, M.D., William Osler Abbott, M.D., J. Gershon-Cohen, M.D., I. S. Ravdin, M.D., Philadelphia. Four-hour course. Sunday, 2 P.M. to 5 P.M., Monday, 8 A.M. to 9 A.M.

The course is planned to cover roentgen anatomy of the stomach, duodenum, and gall bladder, together with changes produced by various pathologies. The physiology will be discussed, particularly as concerns the reflex changes encountered and functional derangements demonstrable by roentgen examination. Physiology, pathology, surgery, and roentgenology will be correlated in open forum discussion by the leader and his associates.

Course No. 2. FILM-READING SESSION. W. Edward Chamberlain, M.D., Philadelphia, and L. H. Garland, M.D., San Francisco. Two-hour course. Sunday, 7 P.M. to 9 P.M.

Those attending the course are invited to bring case reports and radiographs of interest or difficult cases for presentation and informal discussion. Only those cases in which the diagnosis is proved or in which evidence is conclusive should be submitted for discussion. Those conducting the conferences will depend upon voluntary submission of material by those enrolled.

Course No. 3. RADIOLOGY OF THE SMALL INTESTINE: Ross Golden, M.D., New York City. Three-hour course. Monday, 9 A.M. to 10 A.M., Tuesday, 8 A.M. to 10 A.M.

(*A*) Method of examination
(*B*) Normal small intestine
(*C*) Disturbances in physiology:
  1. Multiple peritoneal adhesions
  2. Mesenteric lymphadenitis
  3. Vagotonia
  4. Deficiency states:
    (*a*) Non-tropical sprue; adult celiac disease (chronic steatorrhea), infantile celiac disease
    (*b*) Dietary deficiency
    (*c*) Low serum albumin
    (*d*) Acholia
  5. Allergy
  6. Ileus (paralytic and mechanical)
(*D*) Inflammations:
  1. Tuberculosis
  2. Non-specific enteritis
(*E*) Neoplasms:
  1. Benign
  2. Malignant:
    (*a*) Carcinoma, cardinoid
    (*b*) Lymphoblastomas (localized, diffuse).

Course No. 4. RADIOLOGY OF THE ESOPHAGUS: John T. Farrell, Jr., M.D., Philadelphia. Two-hour course. Wednesday, 8 A.M. to 10 A.M.

The technic of examination of the esophagus and consideration of its diseases form a satisfactory basis for study of many other parts of the gastro-intestinal tract.

Except in the case of metallic foreign bodies, direct examination usually reveals little. Opaque mixtures, pastes, and boluses must, therefore, be used. Complete examination requires study in the erect and prone postures; the importance of the latter is frequently overlooked.

Diagnosis of esophageal disease is based upon the detection fluoroscopically or radiographically of alterations from the normal in contour, motility, and position. Changes in the length, diameter, normal indentations, and peristaltic waves constitute alterations of contour. Delay in the passage of opaque media constitutes the most important alteration of motility. Displacement of the esophagus by external pressure is the most important alteration of position.

Among the conditions to be considered are those due to prenatal influences: atresia, stricture, fistula, congenital shortening, hernia, and diverticulum. Also, those which are acquired: esophagitis, foreign body, varix, compression, post-traumatic stricture, newgrowth, spasm, and the effects of hypochromatic anemia. The radiologic characteristics of each,

their differential diagnoses and complications, will be presented.

Course No. 5. RADIOLOGY OF THE COLON: E. L. Jenkinson, M.D., Chicago. Two-hour course. Thursday, 8 A.M. to 10 A.M.

This course will consist of a review of the anatomy, physiology, and pathology of the large bowel. Diseases of the colon, as diagnosed by roentgen study, will be classified. Methods of examination will be discussed and differential diagnosis outlined.

Course No. 6. KYMOGRAPHY: Wendell G. Scott, M.D., St. Louis, Missouri. Two-hour course. Friday, 8 A.M. to 10 A.M.

The course in roentgen kymography will include a brief discussion of the principles and technic of kymography. The main effort will be directed toward the methods used in the interpretation of kymograms in various types of heart disease, including diseases of the valves, myocardial impairment, coronary heart disease and infarction, and pericardial diseases. The purpose is to demonstrate the clinical uses of kymography and to evaluate the procedure as a clinical aid in the study of heart disease.

A few cases will be shown in which the laminagraphic examination established the diagnosis in several obscure cardiac lesions.

Course No. 7. ROENTGEN ANALYSIS OF FRACTURES: W. Edward Chamberlain, M.D., Philadelphia. Three-hour course. Sunday, 2 P.M. to 5 P.M.

1. *General Considerations.*—The responsibilities of the roentgenologist in the fracture field; the determination of position, including rotary displacements that may be very important yet frequently overlooked; the causes or cause of non-union; safety considerations; medico-legal aspects; records.

2. *Apparatus.*—Biplane and multiplane fluoroscopes, with motion picture demonstration and exhibition of model; safety considerations.

3. *Illustrative Cases* (from the fracture service of John Royal Moore, M.D., Professor of Orthopedic Surgery, Temple University Medical School).—Part-by-part review of fractures of hip, thigh, pelvis, spine, etc., from the point of view of their analysis by roentgen methods and avoidance of pitfalls.

Course No. 8. FILM-READING SESSION. M. C. Sosman, M.D., Boston, and Ross Golden, M.D., New York City. Two-hour course. Sunday, 7 P.M. to 9 P.M.

Those attending the course are invited to bring case reports and radiographs of interest or difficult cases for presentation and informal discussion. Only those cases in which the diagnosis is proved or in which evidence is conclusive should be submitted for discussion. Those conducting the conferences will depend upon voluntary submission of material by those enrolled.

Course No. 9. RADIOLOGY OF THE CHEST: L. R. Sante, M.D., St. Louis, Missouri. Six-hour course. Monday, Tuesday, and Wednesday, 8 A.M. to 10 A.M.

The purpose of this demonstration is to present in logical sequence the various diseases of the chest commonly encountered and to point out the fundamental underlying factors which give rise to these findings.

The presentation will be made in the following sequence:

Lecture 1, *Monday:* Acute inflammatory diseases of the chest.

Lecture 2, *Tuesday:* Atelectasis and conditions associated with partial or complete bronchial occlusion.

Lecture 3, *Wednesday:* Roentgenologic aspects of pulmonary tuberculosis.

Course No. 10. CARDIORADIOLOGY: Samuel Brown, M.D., Cincinnati, Ohio. Two-hour course. Thursday, 8 A.M. to 10 A.M.

The presentation will consist in the demonstration of roentgenographic signs of diseases of the heart and great vessels as revealed by changes in their position, shape, size, relationship, contour, density, mobility, and motility. Cardiodynamics of the heart and vessels by the roentgen kymographic method will receive special attention. The principles and technic will be illustrated by a simple model. Roentgenograms of the common diseases of the heart and vessels will be exhibited.

Course No. 11. SILICOSIS: W. M. Doughty, M.D., Cincinnati, Ohio. Two-hour course. Friday, 8 A.M. to 10 A.M.

Films and lantern slides, showing early findings and later complications of silicosis, and

PLAN OF PRESENTATION

SUNDAY		MONDAY		TUESDAY
2–5 P.M.	7–9 P.M.	8–10 A.M.		8–10 A.M.
				GASTRO-INTESTINAL
1. **Radiology of the Stomach and Duodenum** E. P. Pendergrass, M.D., W. O. Abbott, M.D., J. Gershon-Cohen, M.D., I. S. Ravdin, M.D.	**2.** **Film-reading Session** W. E. Chamberlain, M.D., and L. H. Garland, M.D.	**1 (cont'd).** **Radiology of the Gall Bladder** E. P. Pendergrass, M.D., *et al.*	**3.** **Radiology of the Small Intestine** Ross Golden, M.D.	**3 (cont'd).** **Radiology of the Small Intestine** Ross Golden, M.D.
				CHEST
7. **Roentgen Analysis of Fractures** W. E. Chamberlain, M.D.	**8.** **Film-reading Session** M. C. Sosman, M.D., and Ross Golden, M.D.	**9.** **Radiology of the Chest** **Acute Inflammatory Diseases of the Chest** L. R. Sante, M.D.		**9 (cont'd).** **Radiology of the Chest** **Atelectasis and Conditions Associated with Bronchial Occlusion** L. R. Sante, M.D.
				HEAD AND
		12. **Radiology of the Skull** M. C. Sosman, M.D.		**13.** **Contrast Myelography** John D. Camp, M.D.
				RADIOLOGY
17. **Radiology of Bone Tumors** John T. Murphy, M.D.		**17 (cont'd).** **Radiology of Bone Tumors** John T. Murphy, M.D.		**18.** **Bone Diseases of Children** Leo G. Rigler, M.D.
				THERAPY
	21. **Therapy Clinic** G. E. Pfahler, M.D.	**22.** **Radiation Therapy of the Lymphoblastomas** B. P. Widmann, M.D.		**23.** **X-ray Therapy in the Treatment of Carcinoma of the Skin** James M. Martin, M.D.
		26. **Radiation Therapy of Cancer of the Breast** U. V. Portmann, M.D.		**26 (cont'd).** **Radiation Therapy of Cancer of the Breast** U. V. Portmann, M.D.
				PHYSICS OF
28. **Production of X-rays** R. R. Newell, M.D. **Production of Supervoltage X-rays** L. S. Taylor, Ph.D.		**29.** **Structure of Matter** Otto Glasser, Ph.D. **Radio-activity, Natural and Induced** K. W. Stenstrom, Ph.D.		**30.** **Characteristics of X-rays and Radium Rays** J. L. Weatherwax, M.A.

PLAN OF PRESENTATION

WEDNESDAY	THURSDAY	FRIDAY
8–10 A.M.	8–10 A.M.	8–10 A.M.
SERIES		
4. **Radiology of the Esophagus** John T. Farrell, Jr., M.D.	5. **Radiology of the Colon** E. L. Jenkinson, M.D.	6. **Kymography** Wendell G. Scott, M.D
SERIES		
9 (cont'd). **Radiology of the Chest** **Roentgenological Aspects of Pulmonary Tuberculosis** L. R. Sante, M.D.	10. **Cardioradiology** Samuel Brown, M.D.	11. **Silicosis** W. M. Doughty, M.D.
NEUROLOGIC SERIES		
14. **Encephalography** Cornelius G. Dyke, M.D.	15. **Radiology of Sinuses and Mastoids** G. W. Grier, M.D.	16. **Dental Radiology** C. A. Resch, D.D.S.
OF BONES	UROLOGIC RADIOLOGY	
19. **Radiologic Aspects of the Arthritides** L. H. Garland, M.D.	20. **Radiology of the Genito-urinary Tract** Karl Kornblum, M.D.	20 (cont'd). **Radiology of the Genito-urinary Tract** Karl Kornblum, M.D.
SERIES		
24. **Fundamental Principles of Protracted Fractionated Irradiation** Milton Friedman, M.D.	24 (cont'd). **Fundamental Principles of Protracted Fractionated Irradiation** Milton Friedman, M.D.	25. **Radiation Therapy of Inflammatory Diseases** Ira I. Kaplan, M.D.
27. **Radiation Therapy of Carcinoma of the Cervix** Edwin C. Ernst, M.D.	27 (cont'd). **Radiation Therapy of Carcinoma of the Cervix** Edwin C. Ernst, M.D.	
RADIATION		
31. **Specification of X-ray and Gamma-ray Doses in Roentgens** E. H. Quimby, Sc.D.	32. **Use of Artificially Radio-active Substances in Medicine and Biology** K. E. Corrigan, Ph.D. **Practical Use of Geiger Counters in Radiology** L. Rovner, M.A.	33. **Biologic Aspects of Clinical Effects of X-rays** P. S. Henshaw, Ph.D.

some of the other chest diseases which give trouble in the differential diagnosis.

Course No. 12. RADIOLOGY OF THE SKULL: M. C. Sosman, M.D., Boston. Two-hour course. Monday, 8 A.M. to 10 A.M.

A lantern slide demonstration, using two lanterns simultaneously, of the commoner lesions of the skull and brain which are characteristic or diagnosable by radiographic examination. A short discussion of the differential diagnosis, with remarks on the prognosis and roentgen therapy in cases in which it is applicable. Slides will be shown and discussed.

Course No. 13. CONTRAST MYELOGRAPHY: John D. Camp, M.D., Rochester, Minnesota. Two-hour course. Tuesday, 8 A.M. to 10 A.M.

This course will cover the following aspects of the subject:

Indications for the procedure.

Selection of a suitable medium.

Technic of examination with various substances.

The normal anatomy of the spinal subarachnoid space.

Tumors, protrusion of the intervertebral discs, and other pathologic conditions affecting the spinal subarachnoid space.

Difficulties and complications.

Relative clinical value of the various procedures.

The subject will be presented by means of lantern slides and moving pictures.

Course No. 14. ENCEPHALOGRAPHY: Cornelius G. Dyke, M.D., New York City. Two-hour course. Wednesday, 8 A.M. to 10 A.M.

The Normal Encephalogram.—The normal appearance of the lateral ventricles, third ventricle, aqueduct of Sylvius, fourth ventricle, basal cisterns, and cerebral sulci will be demonstrated. The structures molding and forming the boundaries of the cerebral fluid space will be demonstrated in detail.

The Abnormal Encephalogram.—The appearance of the cerebral pneumograms in abnormal conditions of the brain will be demonstrated. Particular attention will be devoted to the subject of hydrocephalus, and to cerebral lesions following injury.

Course No. 15. RADIOLOGY OF SINUSES AND MASTOIDS: G. W. Grier, M.D., Pittsburgh, Pennsylvania. Two-hour course. Thursday, 8 A.M. to 10 A.M.

The technic which the author has found most satisfactory, and the positions that are used routinely and in special cases will be described.

The apparatus which the author uses to make stereoscopic views of the sinuses easily will be demonstrated.

The various diseases which involve the nasal sinuses will be discussed and films shown to demonstrate these as fully as possible. Special effort will be made to correlate x-ray findings with clinical and pathologic findings.

Acute and chronic mastoiditis will be discussed, and also petrositis. The value and limitations of the x-ray in mastoiditis will be stressed.

Course No. 16. DENTAL RADIOLOGY: C. A. Resch, D.D.S., Cleveland, Ohio. Two-hour course. Friday, 8 A.M. to 10 A.M.

1. Anatomic landmarks of the jaws
2. Limitations
3. Inflammatory conditions
4. Dental anomalies
5. Other considerations of dental interest
6. Technic considerations

These various features of the outline are to be illustrated by lantern slides.

Course No. 17. RADIOLOGY OF BONE TUMORS: John T. Murphy, M.D., Toledo, Ohio. Five-hour course. Sunday, 2 P.M. to 5 P.M. Monday, 8 A.M. to 10 A.M.

This course will be conducted on a clinical-pathological or case study plan. The course is designed to emphasize differential diagnosis and the plan of therapy of bone tumors. The field of bone tumors is to be classified tersely and illustrative cases of each class presented. In most instances serial films will be presented, together with the clinical history and pertinent clinical findings in addition to the roentgen analysis.

Course No. 18. BONE DISEASES OF CHILDREN: Leo G. Rigler, M.D., Minneapolis, Minnesota. Two-hour course. Tuesday, 8 A.M. to 10 A.M.

Numerous diseases produce generalized bone changes in children. Both the characteristic

and atypical roentgen manifestations of certain of these abnormalities including rickets, renal rickets, secondary effects of jaundice and several liver diseases, poor nutritional states followed by excessive vitamin intake, scurvy, congenital syphilis, certain blood dyscrasias, and certain tumors of children will be considered. The underlying pathology as well as the differential diagnosis of some of these conditions will be detailed. Illustrative cases will be demonstrated by means of lantern slides of roentgenograms, pathologic specimens, and by diagrams.

Course No. 19. RADIOLOGIC ASPECTS OF THE ARTHRITIDES: L. H. Garland, M.D., San Francisco. Two-hour course. Wednesday, 8 A.M. to 10 A.M.

Following a definition of the term "arthritis," the author will present a general classification of the arthritides and allied arthropathies. The pathologic appearance of the more important forms of arthritis will be discussed. The diagnosis and differential diagnosis of the various types of arthritis will then be outlined, illustrated with roentgenograms, and presented for brief debate. The lack of correlations between the clinical symptoms and roentgenologic findings in common forms of so-called arthritis will be outlined and an attempt will be made to evaluate the usefulness of roentgen examination in the early diagnosis of certain forms of infectious arthritis. The technic and results of the newer forms of roentgen examination of joints by the use of intra- and extra-articular opaque media and mechanical traction will be considered. If time permits, the value and results of roentgen treatment of a few certain specific types of arthritis will be presented and illustrated by lantern slides.

Course No. 20. RADIOLOGY OF THE GENITO-URINARY TRACT: Karl Kornblum, M.D., Philadelphia. Four-hour course. Thursday and Friday, 8 A.M. to 10 A.M.

This course consists of the discussion of:

1. The flat film examination of the abdomen (normal roentgen anatomy; discussion of the value of the flat film).
2. Retrograde pyelography (normal morphology; simple mechanical obstruction; obstructions of inflammatory origin; obstructions due to neoplastic disease).
3. Congenital lesions (clinical and roentgenologic aspects).
4. Intravenous or excretory urography (physiologic principles; the value of intravenous study; indications and contra-indications).
5. Cystography.
6. Urethrography.
7. The rôle of the urinary tract in the more recent advances of medicine; the participation of the roentgen examination.

Course No. 21. THERAPY CLINIC. G. E. Pfahler, M.D., Philadelphia. Two-hour course. Sunday, 7 P.M. to 9 P.M.

In response to insistent demand by those enrolled in former Refresher Series, a Therapy Clinic is being presented this year. The cases will be chosen from Cleveland hospitals and will be presented with a complete clinical work-up. They will be discussed by Dr. Pfahler from the standpoint of their radiation management. An effort will be made to choose types of cases which will adapt themselves readily to clinical presentation and which will be illustrative of the more common radiation therapy problems.

Course No. 22. RADIATION THERAPY OF THE LYMPHOBLASTOMAS: B. P. Widmann, M. D., Philadelphia. Two-hour course. Monday, 8 A.M. to 10 A.M.

Lymphoblastomas (including discussion of leukemias) are classified as to pathologic, roentgenologic, and clinical manifestations and characteristics. Special consideration is given to the manifold variations, longevity cycle, and response to irradiation. A detailed review and analysis of technical procedures will be made, with supplementary suggestions and recommendations with particular reference to general management along the lines of regulation and control of the physical tolerance according to a predetermined plan of roentgen-ray dosage.

Course No. 23. X-RAY THERAPY IN THE TREATMENT OF CARCINOMA OF THE SKIN: James M. Martin, M.D., Dallas, Texas. Two-hour course. Tuesday, 8 A.M. to 10 A.M.

A brief review of carcinoma of the skin, from 1898 to the present time. Methods of selecting cases, diagnosis, and methods of treatment will be illustrated by means of photographs. Particular stress will be laid on lesions about the face, with their complications and methods of treatment. Methods for keeping records with a five-year follow-up system will be shown and

discussed. The illustrations will be by means of substandard slides and the automatic selectroslide.

Course No. 24. FUNDAMENTAL PRINCIPLES OF PROTRACTED FRACTIONATED IRRADIATION: Milton Friedman, M.D., New York City. Four-hour course. Wednesday and Thursday, 8 A.M. to 10 A.M.

1. Characteristics of irradiation:
   (*a*) Definition of protraction and fractionation.
   (*b*) Review of pertinent physical factors: ray quality, distance, and portal size.
   (*c*) Fractionation. Effect of size of daily dose on destructive and recovery effects. Discussion of experiments by Quimby, Reisner, Love, and Faber. Ideal daily skin and tumor dose under various conditions.
   (*d*) Protraction. Studies in exposure time. Ratio of size of dose to exposure time. Effect of protraction on mitosis.
   (*e*) Total dose.
2. The reaction of the organism:
   (*a*) General phenomena of destruction and recovery.
   (*b*) Radiation reactions: epithelitis, epidermitis, radiation leukoplakia.
   (*c*) Graphic record of reactions, and practical analysis of reaction charts.
   (*d*) Rhythms: inverse pyramid, saturation, pyramid, periodicity, and extended interval.
   (*e*) Histologic studies of effect of different rhythms on tumors of different radiosensitivities.
3. Clinical problems. Case illustrations of the practical application of the above principles.

Course No. 25. RADIATION THERAPY OF INFLAMMATORY DISEASES: Ira I. Kaplan, M.D., New York City. Two-hour course. Friday, 8 A.M. to 10 A.M.

Indications and rationale for the treatment of inflammatory diseases will be discussed. Special consideration will be given to the practical employment of irradiation in the treatment of various conditions, acute and chronic, specific and pyogenic, ophthalmology, otolaryngology, chest, gynecology, urology, and in general medicine. A detailed description of the methods employed, technics and doses used will be demonstrated with the aid of lantern slides.

Course No. 26. RADIATION THERAPY OF CANCER OF THE BREAST: U. V. Portmann, M.D., Cleveland, Ohio. Four-hour course. Monday and Tuesday, 8 A.M. to 10 A.M.

This course will be essentially the same as that given at the Annual Meeting of the Society in Atlanta in 1939.

The anatomy, physiology, and pathology of the breast will be discussed. Differential diagnosis of tumors of the breast and the plan of management will be presented as modified by the extent of the disease. Statistics comparing the different methods of management will be presented and discussed.

Course No. 27. RADIATION THERAPY OF CARCINOMA OF THE CERVIX: Edwin C. Ernst, M.D., St. Louis, Missouri. Four-hour course. Wednesday and Thursday, 8 A.M. to 10 A.M.

1. Introductory remarks—carcinoma cervix uteri:
   (*a*) Approach to the problem
   (*b*) Management of complications
   (*c*) Benign uterine consideration
2. (*a*) Gross morphology of carcinoma of the cervix
   (*b*) Macroscopic misconceptions
3. Planning of the x-ray and radium treatment procedures
4. Physical and clinical data inter-relationships
5. Contra-indications to irradiation treatment of carcinoma cervix
6. Complications to be anticipated before and after treatment
7. Judgment and radiation sense compared to simple ownership of the radium or the x-ray apparatus
8. Advantages of preliminary x-ray therapy preceding radium applications
9. Discussion of the radiation effect upon malignant cells in relation to dosage
10. Radium physics and dosage—histopathology
11. Biopsy and grading advantages and limitations—desirability of prognosis estimations
12. Tumor dose or tissue roentgen measurements:

(*a*) Essential requirements
(*b*) Limitations of the method

13. Physical factors of the tumor dose designation and the practical significance or advantages
14. Precalculation of tumor dose in tissue roentgen
15. Analysis of higher voltage or filtration methods up to 400 kv.
16. Back-scattering: schematic planning of the x-ray and radium irradiations found by us most effective:
    (*a*) Intravaginal radiations
    (*b*) Perineal radiations
    (*c*) Double port of entry methods
17. Inter-related radium applications and dosages.

Course No. 28. PHYSICS OF RADIATION: R. R. Newell, M.D., San Francisco, and L. S. Taylor, Ph.D., Washington, D. C. Three-hour course. Sunday, 2 P.M. to 5 P.M.

Production of x-rays (Newell); production of supervoltage x-rays (Taylor).

Course No. 29. PHYSICS OF RADIATION: Otto Glasser, Ph.D., Cleveland, Ohio, and K. W. Stenstrom, Ph.D., Minneapolis, Minn. Two-hour course. Monday, 8 A.M. to 10 A.M.

Structure of matter (Glasser); radio-activity, natural and induced (Stenstrom).

Course No. 30. PHYSICS OF RADIATION: J. L. Weatherwax, M.A., Philadelphia. Two-hour course. Tuesday, 8 A.M. to 10 A.M.

Characteristics of x-rays and radium rays.

Course No. 31. PHYSICS OF RADIATION: E. H. Quimby, Sc.D., New York City. Two-hour course. Wednesday, 8 A.M. to 10 A.M.

Specification of x-ray and gamma-ray doses in roentgens.

Course No. 32. PHYSICS OF RADIATION: K. E. Corrigan, Ph.D., Detroit, Michigan, and L. Rovner, M.A., Chicago. Two-hour course. Thursday, 8 A.M. to 10 A.M.

Use of artificially radio-active substances in medicine and biology (Corrigan); practical use of Geiger counters in radiology (Rovner).

Course No. 33. PHYSICS OF RADIATION: P. S. Henshaw, Ph.D., Washington, D. C. Two-hour course. Friday, 8 A.M. to 10 A.M.

Biologic aspects of clinical effects of x-rays.

A MEMBER HONORED

Dr. W. Edward Chamberlain, who ended a five-year term as Chairman of the Board of Chancellors of the American College of Radiology at its annual meeting in New York on June 12, was voted a signal honor by the Fellows of the College present at the annual banquet. A resolution submitted by Dr. E. P. Pendergrass, of Philadelphia, to confer the gold medal of the American College of Radiology upon Dr. Chamberlain was unanimously adopted.

The gold medal of the College has previously been presented only to Honorary Fellows. Dr. William D. Coolidge, Dr. Charles C. Lauritsen, Dr. H. Clyde Snook, Dr. Albert Soiland, and Madame Marie Curie have been thus honored.

Dr. Pendergrass called attention to "his tireless effort and boundless enthusiasm, which have brought the College to a position of strength and usefulness beyond that which we even hoped for when he assumed office five years ago" in moving the adoption of his resolution to confer the gold medal upon Dr. Chamberlain.

THE JOURNAL OF THE NATIONAL CANCER INSTITUTE

The National Cancer Institute, of the National Institute of Health, United States Public Health Service, announces the forthcoming issue of *The Journal of the National Cancer Institute*, the official organ of the Institute.

The new Journal, which will be issued bimonthly, will be of the scientific type of periodical, and will contain articles by members of the staff on the various lines of cancer research work carried on by the Institute.

The first issue will include papers on the Federal cancer control program, the approaches to cancer research, the effect of various hydrocarbons in producing tumors in mice, and studies on normal and cancerous tissues.

Copies of the Journal will be sold to applicants by the Superintendent of Documents, Government Printing Office, Washington, D. C., who will also handle all annual paid subscriptions. The price of subscription will be $3.00 a year in the United States.

The Journal will be distributed free to a limited number of medical schools, to workers in the field of cancer research, to research institutes interested in cancer, to a limited number of surgeons, as well as to certain Government depositories, and to journals making suitable exchanges.

COMMUNICATION

MARKET FOR USED FILMS

The following communication has been received from L. E. Wurster, M.D., who originally addressed it to all members of the Pennsylvania Radiological Society. It certainly deserves even wider dissemination.

At the recent meeting of the Pennsylvania Radiological Society, the question of sale of used films was discussed. Many members apparently had been defrauded by firms or dealers purchasing used films.

Recently a Mr. Bender, from Brooklyn, offered me $10.00 for a cabinetful of films. This price was accepted. He then interviewed the Superintendent of the Williamsport Hospital and offered ten dollars for a similar cabinetful of films. She asked him to quote a price per pound, which he refused to do. He raised his offer to $50.00, but this was refused. She then communicated with various firms dealing in used films and received $120.00 for the same amount of films for which Mr. Bender had paid me $10.00. I then made inquiry regarding companies in the business and am passing this information on to our membership.

At present Arthur Blank & Co., 160 Portland St., Boston, Mass., offers twenty-one cents a pound for old x-ray films. Buyer will call for same and pay cash in full before films are removed. They are also accepted C.O.D., providing due notification of shipment is given. The Williamsport Hospital sold the films referred to above at twenty-three cents a pound, cash, to Johnson Process Co., 406 Schiller St., Elizabeth, N. J.

This information may save considerable money over a period of years, as it would have saved me, had I had this information.

L. E. WURSTER, M.D.

IN MEMORIAM

WALTER WENDELL FRAY, M.D.
1892–1940

To those who were not so highly privileged as to have known Dr. Walter W. Fray personally, this note must serve as an announcement of his passing from this life. But to those who knew him—even his casually and quickly met friends—no obituary need ever be spoken, for to them he will always live as the very paragon and prince among men. Walter Fray was not only a master of radiology but was also capably versatile in other medical and non-medical fields. Dogged and beset with numerous misfortunes that would have plowed under the ordinary human, Dr. Fray maintained his marvelous personal virtues and his record of gifted professional achievements until the very last. Rarely has such fortitude been shown during a long, suffering, hopeless illness such as he contracted, possibly as a result of his chosen field. Love of life in all its aspects overflowed in incredible volume for this singular man. Every word and act was honey-dipped in his giant cup of pure humor. Accompanying these qualities were peerless acuity, precision, and foresight in all that he undertook, resulting in the very best combination possible.

Walter W. Fray was born on August 23, 1892, in Catskill, New York. He was the son of John H. Fray and Catherine Brandow Fray, the latter still surviving. Dr. Fray leaves his devoted and very lovable wife, Jessie Walkden Fray, whom he married on May 10, 1929, and who was always a source of great inspiration to him. His early education was received in the Catskill elementary and secondary schools. After obtaining his B.S. degree in 1916 and his M.S. degree in 1917 from Syracuse University, he taught science at Gouverneur and Louville High Schools (New York) before embarking upon the study of medicine. Doubtless, it was this early experience and training in teaching that helped to make him such an outstanding teacher in medicine. He entered Harvard Medical School in 1918 and served in the Army Reserve Corps there during the First World War. In 1922, he received his M.D. from Harvard Medical School and was appointed House Officer in Medicine in the Massachusetts General Hospital, where he served from 1922 to 1924. Dr. Fray then became Resident at the Willard Parker Hospital for the year 1924–1925. He came to Strong Memorial Hospital and the University of Rochester in 1925 as an Assistant Resident in Medicine (Radiology). He was promoted to Instructor in Medicine (Radiology) in 1927 and became Assistant Professor of Medicine (Radiology) in 1930, and was also placed in charge of Diagnostic Radiology. In 1934, Dr. Fray became a diplomate of the American Board of Radiology and also was made a Fellow of the American College of Radiology in

1937. He was a member of the American Roentgen Ray Society, the Rochester Roentgen Ray Society, Rochester Academy of Medicine, Monroe County Medical Society, the New York State Medical Society, and the American Medical Association.

Dr. Fray was extremely fond of teaching—and what an unrivaled pleasure it was to the many medical students, nurses, house officers, and radiologists who listened to him! With a voice both charming and clear and employing ingenious technic, he fascinated his pupils and thoroughly instructed them not only in the subject immediately at hand but in its various related ramifications. The instruction and interpretation periods ended all too quickly for his students and residents. He was unusually sympathetic with his students and their problems. His diagnostic ability was uncanny and based upon the soundest judgment. The Fray pineal gland localizer was but one of the many clever devices and procedures which he developed and employed as aids toward diagnosis. The image of a braid of hair on a chest radiograph puzzled all but him, and his diagnosis was given in his characteristic preciseness with lightning-like rapidity. No senior staff member could confound him on anything related to his fields—his light shone above that of the most austere.

His researches were numerous and always possessed a practical clinical aspect. Thus, he studied with great thoroughness mensuration of the heart and chest, coarctation of the aorta and other congenital abnormalities of the cardiovascular system, pineal gland and choroid plexus orientation, pelvimetry, silicosis and lipoid pneumonia, among many other subjects. His publications were written with great clarity and pointedness. Before entering upon any particular research problem, he would exhaustively study the groundwork of the subject, no matter whether it included mathematics, physics, or petrology. Once he had mastered these frameworks, it was indeed a pleasure to observe him progress, so logically and ingeniously, step by step toward the solution of the problem.

Baseball was one of his dearest loves and even when he was well along in his fatal illness he could bat the ball farther and play the game with more enthusiasm than many of his younger and more physically capable associates. He was a Nature lover and an ardent gardener.

To those of us who were more intimately associated with Dr. Fray, the deepest imprints

The late WALTER W. FRAY, M.D.

were produced by his admirable principles and ideals and the tenacity with which he held to them and fought for them. In these times of attempted regimentation of all classes and increased political finesse, his ardent philosophy of absolute fairness, help for the deserving, and dislike for artful deception, was a stalwart support for those holding democratic and Golden Rule beliefs.

A truly great man and a very lovable character has passed from among us.

So to this master man of thought and word and deed,
Of waves and beams, of images dark, deep, and secret,
May the gentle rays of Cosmos forever tell him of his fruits.

JOHN J. JARES, M.D.

LEWIS L. ROGERS, JR., M.D.

Dr. Lewis L. Rogers, Jr., aged 50, x-ray specialist and World War veteran, died in Wilkes-Barre, Pennsylvania, General Hospital after an illness of two months. He suffered a severe attack of influenza in March and although he rallied from this he never regained

his full vigor and during the last four weeks was under treatment at the hospital.

Dr. Rogers was born in Kingston, Penna., Sept. 12, 1889, son of Dr. L. L. Rogers and Mollie Cushing Rogers. He was the third generation of physicians, his grandfather having been Dr. Joel Jackson Rogers, of Huntsville. After graduation from Wyoming Seminary, he entered University of Pennsylvania and received his degree from that institution in 1913.

After serving his internship with Wilkes-Barre General Hospital he began the practice of his profession in Kingston. When the United States entered the World War, he volunteered his services in the medical corps and, having a knowledge of x-ray, became an instructor in radiology at Camp Oglethorp. He remained in this service for the duration of the war and was later stationed at Washington, with the rank of first lieutenant.

Later, he returned to Wilkes-Barre where he opened an office as an x-ray specialist, which profession he pursued until his last illness. Beside his private practice which extended throughout Northeastern Pennsylvania, Dr. Rogers was roentgenologist for Mercy Hospital and consulting roentgenologist and a member of the staff of Wilkes-Barre General Hospital.

His genial personality and capacity for friendship led him into membership of many clubs and orders. Enjoying the confidence of his fellow physicians, he was a member of the Luzerne County Medical Society, Pennsylvania State Medical Society, and the Radiological Society of North America. His friends in these groups will mourn his passing.

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE HEAD AND NECK IN ROENTGEN DIAGNOSIS. By HENRY K. PANCOAST, M.D., Late Professor of Radiology and Director of the Department of Radiology, University of Pennsylvania; EUGENE P. PENDERGRASS, M.D., Professor of Radiology, University of Pennsylvania, Director of the Department of Radiology, University of Pennsylvania, and J. PARSONS SCHAEFFER, M.D., Ph.D., Professor of Anatomy and Director of the Daniel Baugh Institute of Anatomy, Jefferson Medical College. A volume of 976 pages, with 1,251 illustrations. Published by Charles C. Thomas, Springfield, Ill., 1940. Price: $12.50.

ATLAS OF CARDIOROENTGENOLOGY. By HUGO ROESLER, M.D., F.A.C.P., Associate Professor of Roentgenology, Cardiologist in the Department of Medicine, Temple University School of Medicine and Hospital, Philadelphia. A volume of 124 pages, with 166 illustrations. Published by Charles C. Thomas, Springfield, Ill., 1940. Price: $8.50.

DIE ENTZUNDUNGSBESTRAHLUNG (Irradiation of Inflammations). By DR. R. GLAUNER, Lecturer on Roentgenology at the University of Cologne, Chief Physician at the Roentgen and Light Institute of the City Hospital. A volume of 190 pages, with 14 illustrations and 14 tables. Published by Georg Thieme, Leipzig, 1940. Price: 15.00 R. M. (A 25 per cent discount allowed to all foreign purchasers.)

MAGENPHYSIOLOGIE FÜR RÖNTGENZWECKE (Gastric Physiology for Roentgenologic Purposes). Principles of Physiologic Interpretation of Roentgenologic Findings. By DR. G. A. WELTZ, Roentgenologist, Lecturer and Head of the Division at the Physiologic Institute of the University of Munich. A volume of 77 pages, with 62 illustrations and a device for reproducing movements in the film. Published by Georg Thieme, Leipzig, 1940. Price: 12.00 R. M. (A 25 per cent discount allowed to all foreign purchasers.)

ABSTRACTS OF CURRENT LITERATURE

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ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

THE INTESTINES

The Roentgen Diagnosis of Idiopathic Steatorrhea and Allied Conditions: Practical Value of the "Moulage Sign." John L. Kantor. Am. Jour. Roentgenol. and Rad. Ther., **41,** 758–778, May, 1939.

This clinical syndrome is closely related to tropical sprue and includes, in addition to the "non-tropical sprue" of adults, celiac disease, idiopathic or intestinal tetany, and the steatorrhea associated with certain organic diseases such as lymphosarcoma of the intestine, lymphosarcoma of the mesenteric lymph glands, and gastrocolic fistula. Common to all these is a failure of the small intestine to absorb fat, carbohydrate, calcium, and sometimes phosphorus, antianemic factors, and important vitamins.

Clinically, there results a persistent diarrhea, characterized by the passage of voluminous, foul, greasy, or frothy and soapy, stools, and marked loss of weight. The calcium loss results in irritability, tetany, and spasmophilia. Anemia of various types occurs. Opacities of the lens of the eye may occur, as well as disturbances of water metabolism. The roentgen findings may be of great importance and are characteristic. They are not constant or present in every case but vary in their degree and distribution, depending on the activity of the disease and constitution of the individual.

In the small intestine the changes are most apparent in the jejunum, where variations in tone, caliber, and motility occur, especially in the diminution or complete disappearance of the distinctive valvulæ conniventes, which results in a smooth lumen, as though wax had been poured into it. This is the "moulage sign." This sign varies directly with the intensity of the disease and, therefore, is of value both in the diagnosis and prognosis.

The colon shows marked dilatation often associated with redundancy. The gall bladder fills faintly and the bony skeleton reveals porosis, dwarfism, and deformity. Six cases are presented in detail and the literature is reviewed.

S. M. Atkins, M.D.

Disorders of the Small Intestines. Sir Edmund Spriggs. British Med. Jour., **1,** 1015–1019, May 20, 1939.

The author gives a concise but careful review of the commoner conditions of the small intestines frequently encountered in the x-ray laboratory and describes the incidence, diagnosis, and treatments thereof in a manner which should command the attention of any practitioner. He points out the vital importance of the small intestine by calling attention to the effects of enteritis, cholera, and obstruction of this organ on the body in general and states also that it is possessed of a remarkable immunity as compared with other organs. The conditions discussed are: duodenal ulcer, post-operative disorders, mechanical interference, diverticula, tuberculosis, regional ileitis, intussusception, actinomycosis, and, finally, growths and foreign bodies.

Following is a summary of his discussions:

Duodenal ulcer is the commonest disease of the small intestine. The author published a paper on this subject over thirty years ago describing his first series of peptic ulcer cases and discussing the treatment briefly.

Of disorders of the jejunum following gastric surgery, it is stated that such cases are generally decreasing, probably due to more effective surgery. One series some time ago comprising 166 cases showed a lack of relief post-operatively in 151 instances. Modern surgeons place the percentage of unsuccessful cases at approximately 5 to 10 per cent. The author states that careful roentgenography is essential in demonstrating pathology of this nature.

Mechanical interference occurs more often toward the end of the ileum, due to adhesions. However, the small intestine seems to be quite tolerant of adhesions, and interference by gradual pressure is the cause of symptoms that may long remain unrecognized. In such instances the patient may be labeled a neurasthenic. In discussing the diagnosis of this condition, reference is made to the custom of observing the barium-filled bowel at frequent intervals following ingestion. Infections of the small intestine occur only occasionally. The author states that only 1 per cent of his patients showed such a condition.

Diverticulosis is discussed under the headings of duodenal and jejunal pouches. The size of the former varies from that of a bean to a four-inch bag, while the latter is usually quite large. Diagnosis is routinely by x-ray examination and treatment is mainly dietary. Diverticula of the ileum resemble those of the colon and the symptoms are similar.

Tuberculosis of the small intestine is quite rare and often a final stage. In regional ileitis the terminal part becomes thick, edematous, and rigid and then narrow and ulcerated. Intussusception of the small intestine has been observed only three times by the author; actinomycosis only once. Primary growths of the small bowel are rare and varied in nature. The foreign bodies listed in his series consist of one gallstone, two tape worms, and one round worm.

The author stresses the necessity of a careful, detailed roentgenographic examination in all cases.

Q. B. Coray, M.D.

THE KIDNEYS

Congenital Posterior Urethral Valve Causing Renal Rickets: Report of a Case. Harry A. Derow and M. Leopold Brodny. New England Jour. Med., **221,** 685–690, Nov. 2, 1939.

This is an extensive report of a case of renal rickets developing in a 16-year-old male as a result of kidney damage caused by a posterior urethral valve. The patient had all the evidence of renal rickets, with ground-glass appearance of the thin skull bones and

numerous small round areas of increased density. The long bones showed moderate osteoporosis. The epiphyses showed irregularities, cupping, and abnormal development. The urethral valve was demonstrated by urethrography. The parathyroid glands were found enlarged, at autopsy.

JOHN B. MCANENY, M.D.

Hematuria, Renal Colic and Acetyl-sulphapyridine Stone Formation Associated with Sulphapyridine Therapy. I. Snapper, S. H. Liu, H. L. Chung, T. F. Yü, and H. M. Sun. Chinese Med. Jour., **56,** 1–9, July, 1939.

The authors report four cases presenting either hematuria or renal colics after the administration of sulphapyridine. At one autopsy, crystals of acetyl-sulphapyridine were recovered from the kidneys. These writers believe these crystals acted as calculi, causing the hematuria and pains. In two of the cases the hematuria was asymptomatic.

ANTONIO MAYORAL, M.D

Congenital Solitary Kidney. J. E. Nichol. Canadian Med. Assn. Jour., **41,** 284–286, September, 1939.

By solitary kidney is meant congenital lack of development of the upper urinary tract on one side of the body. One author reports finding ten cases in 10,000 autopsies, another collected 572 cases from the literature and added nine of his own. The condition occurs more frequently in males. The average age at death is 40 years. Possibility of congenital solitary kidney must be kept in mind in renal surgery.

The author presents four cases.

Case 1. A male, 62 years of age, suffered suppression of urine for seven days. Cystoscopic examination showed the right ureteral orifice in normal position but no evidence of a left orifice. Because of the anuria, no dye was given intravenously. The patient died 16 days later. Autopsy showed a large pyonephrotic sac and numerous small abscesses in a normally shaped right kidney and complete absence of left kidney and ureter.

Case 2. A woman, 44 years of age, complained of radiating pain in the right side of the abdomen. On cystoscopic examination the ureteral orifices appeared in normal position. The left orifice showed no contraction or secretion and did not permit the passage of a catheter. An intravenous pyelogram revealed on the right side a hydronephrosis and on the left a large opaque shadow in the kidney area and an absence of dye. Because of the opaque shadow, surgical interference was thought advisable. A small sac containing calcareous material was in the position normally occupied by the left kidney. The left renal pedicle and ureter were fibrous bands. These were considered to be the remains of an undeveloped kidney and ureter.

Case 3. A man, 32 years of age, complained of epigastric pain with no definite relation to food intake. Pus was present in the urine. On cystoscopic examination the left ureteral orifice appeared normal, the right was absent. Intravenous pyelogram revealed a large normally shaped hydronephrotic kidney on the left, while on the right there was no evidence of a kidney shadow. Under medical management amelioration of symptoms has occurred.

Case 4. A man, 35 years of age, complained of lumbosacral pain for six years and radiating pain in the right side of the abdomen for one year. On cystoscopic examination, the right ureteral orifice appeared normal. A small dimple indicated the position of the left orifice. Intravenous pyelogram revealed an enlarged right kidney of normal shape but no evidence of a functioning left kidney. In view of cystoscopic and roentgenographic findings, a diagnosis of congenital solitary kidney was made.

M. L. CONNELLY, M.D.

THE KNEE

Osteoclastoma of the Patella: Case Report. S. N. Chatterjee. British Jour. Radiol., **12,** 316, 317, May, 1939.

A woman, aged 22, developed a painful, red, tender, fluctuant swelling of the right knee at the third month of pregnancy. X-ray examination showed complete destruction of the patella, with many spicules of new bone irregularly placed in the area. Biopsy revealed an osteoclastoma. The patient was treated by irradiation. The result is not reported.

SYDNEY J. HAWLEY, M.D.

Fracture and Dislocation of the Patella. E. P. Brockman. British Med. Jour., **2,** 963–965, Nov. 11, 1939.

The author offers a concise description of injuries to the patella and associated tendons under the topics of rupture of the quadriceps tendon and rupture of the patellar tendon.

The commonest injury in this region is a transverse fracture, the cause of which is a sudden contraction of the quadriceps tendon. Comminutions are caused by direct violence. Rupture of the quadriceps tendon occurs occasionally and rupture of the patellar tendon very rarely. Transverse fractures may not be diagnosed until an x-ray examination is made.

Treatment is discussed under the headings of first aid, surgery of the various fractures, and repair of ruptured tendons. Traumatic dislocation, a rare accident, is discussed briefly.

Q. B. CORAY, M.D.

PNEUMONITIS

Acute Interstitial Pneumonitis: A New Disease Entity. D. F. Smiley, E. C. Showacre, W. F. Lee, and H. W. Ferris. Jour. Am. Med. Assn., **112,** 1901–1904, May 13, 1939.

In October, 1937, in the Cornell University Infirmary, there began to appear a type of infection of the respiratory tract different from anything previously seen there. It had as its cardinal feature specific lesions in the lungs inaudible to the stethoscope but

definite in the roentgenograph of the chest. To this disease has been applied the term "acute interstitial pneumonitis."

The onset of the disease is usually not sudden but is ushered in by a period of weakness, malaise, and slight fever lasting for two or three days. The elevation of temperature is gradual and there is cough, pains in the chest, or sore throat or a combination of these symptoms. With a temperature of 100 to 102° and pharyngitis or cough, there are no physical signs of consolidation and little or no sputum.

Definite roentgenographic evidence may not appear until from 36 to 48 hours after the clinical onset. There is increased density in the hilar shadows with a fan-shaped accentuation of, and a numerical increase in, the linear pulmonic markings radiating into the adjacent lung-field. Extension is to the base, in the majority of cases. The suggestion is that of an intense congestion rather than a true consolidation of lung tissue. The visible changes did not usually extend to the margin of the lung, and they cleared rather rapidly in subsequent roentgenographs, ordinarily in from one to two weeks. In more serious involvement the roentgenographic image was that of a bronchopneumonia.

The pneumonitis terminates by lysis; there is no spectacular crisis.

CHARLES G. SUTHERLAND, M.D.

THE PROSTATE

The Roentgenogram in Tuberculosis of the Prostate. Bo Stenström. Acta Radiol., **20,** 303–313, June, 1939.

In the prostates of patients suffering from tuberculosis of the epididymis frequently cavernous changes can be demonstrated by means of urethrography. These cavities may be small and multiple or large and solitary. About 60 per cent of the examined patients showed such changes. In gonorrheal prostatitis similar cavities may occur but they are rare and, as a rule, represent enlarged ducts only.

As a contrast medium, thorotrast was employed; iodized oil is contra-indicated on account of the danger of embolism which exists in urethrovascular reflux.

ERNST A. SCHMIDT, M.D.

Deep X-ray Therapy in Prostatic Enlargement. R. A. Stoney. Irish Jour. Med. Sci., **165,** 704–708, September, 1939.

The author recounts some of his experiences with irradiation of enlarged prostates. In general, he has found the results encouraging and has made no selection of patients. Some cases were *in extremis* when treated, others were in poor physical condition because of the advanced stage of obstruction. Acute complete obstruction has occurred during and as a result of treatment.

In all, 19 cases were treated. Eleven were evaluated as cured (two improved; one unchanged; one no change; four died, and two untraced).

No dosage or technic is given.

JOHN B. MCANENY, M.D.

RADIATION

Symposium on Three-dimensional Radiation Distributions. J. Honeyburne, L. F. Lamerton, D. W. Smithers, and W. V. Mayneord. British Jour. Radiol., **12,** 269–302, May, 1939.

This symposium is of considerable importance and deserves the careful study of all interested in therapy. As most of the article consists of illustrative curves, it cannot be adequately covered by an abstract.

By means of the "contour projector," described in the previous article in the same journal, three-dimensional distribution of radiation is described for the following conditions: planes inclined to the axis of the x-ray beam; distribution in two directly opposite fields; distribution in the female pelvis; distribution with a three-field technic; distribution in planes inclined to the axis of a gamma-ray beam; distribution in a head and neck using a five-field technic; distribution in planes inclined to a ring source of radium, and distribution in the neighborhood of radium needles.

SYDNEY J. HAWLEY, M.D.

Report on Medical Progress: Radiation Therapy. Richard Dresser. New England Jour. Med., **221,** 386–388, Sept. 7, 1939.

Dresser discusses some basic principles of irradiation and the difference between radium and x-radiation. The protracted method of irradiation is discussed and the skin and mucous membrane reactions described. Warning is given as to operative procedures in which this type of irradiation is given.

Two rules of irradiation are given: first, uniform distribution, and second, sufficient intensity to destroy the neoplastic tissue only.

It is found that in carcinoma of the skin, the larger the lesions the lower the percentage of complete cures. Carcinoma involving the cartilage of the nose is amenable to radiation, while that of the ear is not and is often better handled by surgery. Carcinoma about the eye is best treated by radiation.

The author believes that small carcinomas of the lip should be excised and larger ones irradiated. The nodes of the neck should be resected. This whole problem is unsettled.

Malignant lesions of the mouth, pharynx, and larynx should be irradiated, after biopsy.

Treatment of carcinoma of the breast is fairly well known. In localized growths, surgery is the choice procedure. When the axillary nodes are involved, postoperative irradiation should be given. Inoperable cases should have irradiation. Contra-indications to surgery are metastatic nodes above the clavicle, distant metastasis, and inflammatory types of carcinoma. Sterilization of young women is advocated.

In carcinoma of the cervix, radium and x-rays are used. In the fundal type hysterectomy is advised. Ovarian carcinoma should be removed surgically and followed by irradiation.

Bladder and prostatic cancers may respond to irra-

diation. Testicular embryomas should be irradiated at least before they are removed. Wilms' tumor is the only renal tumor that responds well to radiation.

Neoplasms of the alimentary tract and lung are best treated by surgery, with the possible exception of rectal cancers.

Osteogenic sarcoma is best treated surgically. Ewing's tumor and giant-cell tumors may be irradiated.

J. B. McAneny, M.D.

The Treatment of Induratio Penis Plastica by Near Distance Radiation. W. Knierer. Strahlentherapie, **66,** 143, 144, 1939.

The author saw six cases of induratio penis plastica and treated them by means of near distance radiation. One patient was cured and has remained well so far for 10 months; three were improved; one did not respond, and one started treatment about the time of the writing of the article. No definite statement can be made regarding dosage because the cured patient had only 2 × 200 r at eight-day intervals, while the patient who did not respond received a total of 1,400 r in fractional doses over a period of two months.

Ernst A. Pohle, M.D., Ph.D.

X-rays—Their Influence in Pure and Applied Science. G. Shearer. British Jour. Radiol., **12,** 419–431, July, 1939.

In 1904 Barkla discovered the x-ray phenomenon analogous to polarization of light. In 1912 von Laue predicted diffraction phenomena and Friedrich and Knipping produced the first diffraction photograph. In 1913 Bragg built the first x-ray spectrometer. Since then developments have been very rapid. These discoveries have not only given knowledge of x-ray frequencies, but have opened a wide field of study in physics, chemistry, and industry.

Moseley studied the high frequency spectra of the elements and showed the position of the elements in the periodic table to be dependent on the atomic number. This has led to the discovery of new elements and to knowledge of the structure of the atom. X-rays supply us with knowledge of the arrangement of atoms in crystals and also the distance between the atoms. This information can be obtained from the single crystal, and also from powdered crystals, which enhances its usefulness, bringing into the scope of the study almost all solids. Many substances thought to be amorphous are found to be crystalline. It allows study of the structure of alloys.

In 1921 the study of organic compounds was begun. The first studies showed that the concept of the chemists as to the structure of the aromatic and aliphatic compounds was essentially correct, and further showed the size of the benzine ring and the length of the aliphatic chain.

Silk, cotton, wool, rubber, and hair were shown to be crystalline. The elasticity of hair and muscle was shown to be due to a change in the form of the molecule in the relaxed state and the contracted state.

X-rays are very useful in industry. For example, they give us a ready means of determining the size of crystals in metals upon which the properties of the metal depend. X-rays may be used also in the identification of substances as well as the determination of the chemical state of the substance. They are very useful in determining fatigue and structural defects in metals.

Sydney J. Hawley, M.D.

RADIUM

The Treatment of Carcinoma Vulvæ. Percy Malpas. Proc. Royal Soc. Med., **32,** 301–304, February, 1939.

Carcinoma of the vulva presents specially difficult problems and is not quite common enough for any one man to acquire wide experience. The lesion varies widely from an actively growing tumor in comparatively young women to slow superficial ulceration in the very aged.

Before 1925, only radical vulvectomy was available. Then radiation was tried but fell into disrepute because of the high incidence of burns and local recurrences. In the past few years improved results permit radiation to be weighed seriously against radical vulvectomy.

The choice of treatment rests on: (1) state of regional lymphatics; (2) site, type, and extent of growth; (3) rate of growth; (4) condition of the vulva, and (5) condition of the patient.

The vessels supplying the vulva are practically end-arteries. Their occlusion by over-irradiation causes slow healing or secondary necrosis. Post-menopausal atrophy makes a healthy reaction to radium difficult.

Free lymphatic drainage requires that the whole vulva, mons and perineum, be irradiated. We should speak of radical radiation as well as of radical vulvectomy.

Radical vulvectomy is preferable in cases in which the tumor is mobile and the glands are not involved. Vulvectomy is preferable for diffuse leukoplakia with small growths. In very slowly growing lesions, radium is to be preferred because it does not break down the local resistance to the spread of the growth.

Removal of glands is a moot point. If they are not enlarged and the lesion is active, it should be done. With slowly growing cancer in old and feeble patients, free vulval excision and radiation of glands may be better. The author favors leaving the inguinal wounds wide open, making the interesting point that sutures here collect lymph from the adjacent regions and infection is unavoidable.

Radium therapy is favored even in early cases without involved glands, under the following conditions: when the vestibule is involved; when the lesion is large or multiple ulcers are present; poor general condition; slow-growing lesions; an amenable patient, or local recurrences after vulvectomy.

The author considers interstitial radiation to be the best method and gives details which should be read in the original.

Ray A. Carter, M.D.

Epithelioma of the Vulva. J. Eric Stacey. Proc. Royal Soc. Med., **32,** 304–307, February, 1939.

Stacey cites a heightened incidence of vulvar carcinoma in Sheffield: work involving bituminous oils may be a factor. He cites the earlier poor results obtained from radiation, and the great improvement in technic from 1935 to the present. The details of radium treatment should be read in the original.

In 36 cases primarily treated by radium from 1935 to 1937, subsequent vulvectomy has been necessary in only five cases: twice for radium necrosis, three times for recurrences. Of these, 20 patients (55 per cent) are alive to-day.

Factors contributing to failure of radiation are extensive growth, poor blood supply and lymph drainage, previous scarring, over- or under-dosage.

Points favoring radium are absence of shock, operative mortality and mutilation, minimum danger to the urethra, and wider application. Points favoring surgery are no necrosis, less subsequent discomfort, removal of precancerous tissue, and ability to deal with inguinal glands.

Dr. Stacey cites the more recent improvement of radiation in this field and mentions favorably in this connection the work of Dr. Frank Ellis, of Sheffield.

RAY A. CARTER, M.D.

The Work of the Sydney Hospital Radium Clinic, from 1911 to 1938, and an Analysis of the Cutaneous Neoplasms Treated. Sylvia Bray. British Jour. Radiol., **12,** 303–311, May, 1939.

After a brief review of the history of the Clinic and an outline of the conditions treated during the period covered, a statistical analysis of the rodent ulcers and squamous-cell epitheliomas treated is given. Details of the results obtained are not given for the period prior to 1931.

Since 1931, 3,990 rodent ulcers were treated as follows: 2,614 by radium alone; 936 by radium and carbon dioxide snow; 278 by carbon dioxide snow and cautery; 81 by radium and surgery; 43 by radium, cautery, curettage, or diathermy; 36 by surgery alone. Of these, 3,581 patients, or 89.75 per cent, were symptom-free at the end of the period.

Patients totalling 1,582 with squamous-cell epithelioma were treated, of whom 1,287, or 80.79 per cent, were symptom-free at the end of the period.

SYDNEY J. HAWLEY, M.D.

History of a Burnt Tube of Radium: Practical Deductions. T. Nogier. Bull. et mém. Soc. de radiol. méd. de France, **27,** 37–40, January, 1939.

A tube of radium was thrown into a furnace with some soiled dressings which were burned. The author describes the method by which the tube was discovered in the cinders. When recovered, there was a great loss of radio-activity which might have been due to loss of radium or of emanation. By electroscopic check on the radium container after it had been sealed in a glass tube, it was determined that there had been no actual loss of radium, the entire amount of which was recovered and placed in a new container. The author cautions against the burning of any dressings which have been used in conjunction with radium therapy, and also recommends that radium containers be made of platinum because of the higher melting point.

It must not be forgotten that a loss of emanation can simulate loss of radium and electroscopic determinations of the radium in a sealed container must be continued for 30 days to eliminate this factor.

S. R. BEATTY, M.D.

Protective Materials in the Use of Radium Surface Applicators. J. E. Roberts. British Jour. Radiol., **12,** 246–251, April, 1939.

Tests of wax, copper, and lead were made by means of a thin-walled ionization chamber to determine which is the most suitable to use as a protective material for protecting the normal areas in surface application of radium. The tests indicate that, in spite of its higher beta-ray emission, lead is the best protective material. The greatest possible thickness should be used. Covering the lead with a thin layer of copper reduces the ionization but has no practical application, as the beta rays from the lead shield do not penetrate to the sensitive layers of the skin.

SYDNEY J. HAWLEY, M.D.

Simple and Precise Measurement (of Dosage) in Curiepuncture and Intracavitary Applications. Roques. Bull. et mém. Soc. de radiol. méd. de France, **27,** 43–50, January, 1939.

In an article too long for adequate summarization, the author demonstrates a method of dosage calculation for radium needles and tubes based on measurements with the ionomicrometer and the microchambers of Mallet.

With the aid of a table, which is included, and a few simple calculations it is possible to determine the time required for various applications and arrangements of applications necessary to deliver a dose of 1 M.C.D. to each cubic centimeter of tissue. A method of compensating for overlapping of the fields of irradiation is illustrated.

S. R. BEATTY, M.D.

Estimation of the "Quality" of Depth Radiations in Gamma-ray Therapy by Means of the Ionization Produced in Chambers with Wall Materials of Different Atomic Numbers. C. W. Wilson. British Jour. Radiol., **12,** 231–238, April, 1939.

The author first gives a method of calculating the ratio of ionization in two ionization chambers made of different materials and for calculating the change in wave length of gamma rays as they penetrate tissues. The figures obtained are too theoretical for practical application but serve to give an idea of the change to be expected.

Measurements were then made using a four-gram radium unit, fields of 3.5 and 9 cm. diameter, a water phantom, and two ionization chambers, one of copper

and one of electron metal. The results show that ionization chambers made of electron metal are satisfactory for measuring depth radiation in teleradium therapy.

With the small sized field, it was found that the effective wave length at a depth may be twice that of the primary beam. The change in quality is larger with large fields. As back-scatter is low with gamma rays, this indictes that to keep the effective wave length as short as possible the volume of tissue irradiated should be kept as small as possible.

SYDNEY J. HAWLEY, M.D.

The Development of Fibrosarcoma as a Result of the Intra-articular Injection of Radium Chloride for Therapeutic Purposes: A New Form of Radium Poisoning in Human Beings. Flemming Norgaard. Am. Jour. Cancer, **37,** 329–342, November, 1939.

A brief review of the literature on radium poisoning is presented. A detailed case report is given concerning a 56-year-old woman who developed a fibrosarcoma of the tibia following numerous radium baths, radium drinks, radium packs, and finally a "radium injection" into the right knee joint and shoulder for a chronic arthritis 10 years before she developed the tumor. Distinct signs of radio-activity were found with the Geiger counter when applied to the knee and shoulder. The amount of radium chloride injected was definitely known to have been 10 micrograms. The effect from the baths, packs, etc., was considered negligible. Radio-activity corresponding to from 3 to 4 micrograms of radium was demonstrated in the amputated knee. The injection of radium salts for the treatment of benign conditions is condemned.

HAROLD O. PETERSON, M.D.

THE RECTUM

Treatment of Carcinoma of the Rectum. Tullio Moscariello. Arch. di radiol., **15,** 514–528, July–October, 1939.

Moscariello reports the results of radium treatment of 57 proved inoperable cases of carcinoma of the rectum, and outlines his technic of treatment. Six cases were cured for four years or more; of these, two have been followed five years and one for ten years.

EUGENE T. LEDDY, M.D.

Radiological Treatment of Cancer of the Rectum. Elis Berven. Acta Radiol., **20,** 373–390, August, 1939.

The author reports his results in 177 cases of cancer of the rectum, the majority of which were treated with x-ray. About 60 per cent of the cases were considered inoperable. The benefit of x-ray treatment was demonstrated by the fact that of the untreated inoperable patients about 33 per cent died within one year, while of those irradiated the mortality during the first year was lowered to 13 per cent.

Based on his experience at the Radiumhemmet and other radiologic centers, Berven proposes the following indications for the treatment of rectal cancers:

1. Early, highly differentiated carcinomas suitable for operation should be dealt with by radical surgery without preliminary irradiation. However, in undifferentiated types, pre-operative roentgen treatment is advisable.
2. Operable cases in which operation is refused or contra-indicated should be treated radiologically.
3. Cases with large disintegrating operable tumors and all borderline cases should receive pre-operative radiation therapy.
4. Radiation therapy improves the results after excision of less malignant and well-circumscribed tumors, and may, in some instances, even render a radical operation unnecessary.
5. Cases of incomplete operation and recurrences should receive radiotherapy but the end-results are admittedly poor.
6. All inoperable cases should be given radiotherapy if their general condition allows it. Not only can palliation of symptoms and prolongation of life be expected, but in some cases patients obtain permanent freedom from symptoms or are made amenable to radical operation with subsequent permanent cure.
7. Anorectal carcinoma of the cutaneous type should first be treated radiologically.
8. Further improvement of results will probably be made by development and improvement of our radiation technic.

ERNST A. SCHMIDT, M.D.

SILICOSIS

The Present Status of Silicosis. A. J. Lanza. Ohio St. Med. Jour., **35,** 929–932, September, 1939.

Because of the increasing trend to consider silicosis as a compensable occupational disease, the incidence, pathology, and prevention of this condition is a very serious consideration of both the industrial and actuarial physician. In spite of the supposed prevalence of the disease, incapacitated cases are relatively few, as revealed by some of the compensable cases reported in Table I.

TABLE I

	Cases Reported	Disability Allowed
Ohio, 1937	40	19 of 75 acted upon
Ohio, 1938 (compulsory reporting)	146	
Mass., 1937	14	11
Mass., 1938	14	7
New York, 1937		13

Apparently increased precautionary measures, such as settling dust, use of masks and filters, and careful medical and roentgenologic examination of workers, both pre-employment and periodically, have all done their part. The importance of roentgenologic group survey is stressed and the author quotes the analysis of S. R. Warren regarding the use of paper or celluloid films in surveys:

"It is apparent from the data so obtained that paper roentgenograms may be used for survey work if the technic is at least equal to that used in the tests and if

means are available for following up suspicious cases by the use of stereoscopic roentgenograms on x-ray film. This conclusion is qualified by the fact, noted by most of the men who examined the films, that x-ray film has a wider range of density than x-ray paper."

The author also stresses the incidence of increased tuberculosis in silicotics but does not explain the cause of this affinity. He feels that, although a few silicotics develop cardiac findings as a result of pulmonary fibrosis (cor pulmonale), the majority of silicotics with cardiac findings are just those who have not been afflicted with tuberculosis; these have lived long enough to develop heart disease due to the other usual etiologic factors prevalent in the later decades.

SIMON POLLACK, M.D.

The Silicosis Hazard in Mechanical Dentistry. Louis E. Siltzbach, with technical assistance of Jack Siegel, chemist. Jour. Am. Med. Assn., **113**, 1116–1119, Sept. 16, 1939.

This is the case report of a male, aged 35, who for 19 years had been employed in the same dental laboratory where his work consisted exclusively of polishing dentures. The polishing machine which the patient used was located in a small alcove 30 feet from the nearest window. No suction device or other means of ventilation was provided to draw off the dust.

In January, 1937, a small hemoptysis occurred and this recurred at intervals thereafter. He entered a hospital for treatment in August, 1937. He died April 23, 1938. The postmortem diagnosis was far advanced silicotuberculosis.

Analysis of the polishing powder showed a 72 per cent content of silica. A chemical analysis of the pumice used in this laboratory showed that it contained 48 per cent free silica. A substitute was being sold containing silica sand ground to a greater degree of fineness than that of pumice.

The necessity for equipment of dental laboratories with exhaust hoods was made apparent in this study.

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THE SKIN

The Sensitivity of Skin to Roentgen Rays and its Dependence of the Central and Peripheral Nervous System. H. Bade. Strahlentherapie, **66**, 50–65, 1939.

The author studied the sensitivity of the skin of white rats to roentgen rays and the influence of the central and peripheral nervous system on the reaction. He produced a second-degree reaction on skin areas which had been depilated first. Following a dose of 2,000 r, the principal reaction is seen after four to five days; it continues then in a cycle with a peak between the eighth and ninth days and beginning of peeling around the fourteenth day. After a month, a thin, smooth scar with permanent alopecia usually results. If the spinal cord had been severed the latent time was decreased to 10 days and the reaction took a slower course. Severance of the anterior and posterior roots on one side producing a paralysis of the lower extremity increased the latent time to from six to eight days. It is assumed that the observed phenomena are due to circulatory disturbances occurring in the paralyzed extremity.

ERNST A. POHLE, M.D., Ph.D.

The Difference in the Skin and Tissue Reactions to Hard and Soft Roentgen Rays. A. Frank. Strahlentherapie, **66**, 66–72, 1939.

The author exposed small skin areas in 14 patients to two qualities of roentgen rays: 160 kv., 3 ma., 0.5 mm. Cu + 1 mm. Al, 20 cm. distance, 40 r/min., $H.V.L._{Cu}$ = 0.737 mm., and 110 kv., 2 ma., 1 mm. Al, 20 cm. distance, 40 r/min., $H.V.L._{Cu}$ = 0.13 mm. The dose in each instance was 1,600 r. It appeared that the radiation of shorter wave length caused much more marked reactions than the one with longer wave length. Since all other conditions were the same, the author contends that opinions expressed to the contrary in the literature are erroneous. It is necessary, however, to use as high single doses as he did in order to demonstrate this difference in reaction.

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